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VOL IV

THERMAL DESORPTION/ULTRAVIOLET PHOTOLYSIS PROCESS TECHNOLOGY RESEARCH, TEST, AND EVALUATION PERFORMED AT THE NAVAL CONSTRUCTION BATTALION CENTER, GULFPORT, MS, FOR THE USAF INSTALLATION RESTORATION PROGRAM, VOLUME IV

R.W. HELSEL, R.W. THOMAS

EG&G IDAHO, INC.
P.O. BOX 1625
IDAHO FALLS ID 83415

DECEMBER 1987

FINAL REPORT

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19. ABSTRACT (Continue on reverse if necessary and identify by block number)
The objective of this effort was to examine the feasibility of using a thermal desorption/ ultraviolet (TD/UV) destruction technology to treat Herbicide Orange (HO)-contaminated soil at the Naval Construction Battalion Center (NCBC), Gulfport, Mississippi. The IT Corporation pilot -scale TD/UV apparatus was used to successfully treat 1700 pounds of sandy-loam, cement stabilized, soil that had been contaminated with HO and 2,3,7,8 tetrachlorobenzo-p-dioxin (TCDD). The TD/UV process volatilizes organic compounds from the soil matrix; collects the desorbed organics in a solvent; and, destroys the contaminants with high-intensity ultraviolet light. The desorption process occurs between 850 to 1150 degrees F. in a nitrogen atmosphere to prevent combustion of the organics. Analysis of feedstock showed TCDD levels ranged from 233-272 parts per billion (ppb). Concentration in the treated soil, measured as the sum of all dioxin/furan congeners, was less than 1ppb, the USAF criterion. The TD/UV process demonstrated the capability to treat dioxin-contaminated soil
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and a scaled up version could be considered as a bulk reduction process for restoration of sites contaminated with chlorinated organic compounds including other DOD Herbicide Orange contaminated sites. Sensitivity analyses of six variables (geographic) location, soil quantity, electrical power prices, labor, capital equipment use charge, and transportation) were performed to estimate the cost for conditions other than those found at NCBC. The cost to treat one ton of contaminated soil using a scaled up system, based on treatment of 20,000 tons at NCBC, is $402/ton. The process may have application for treatment of other chlorinated organic compounds. The process may have unique application in geographical areas where incineration would not be accepted.

One negative aspect is that the photolysed solvent remains a hazardous waste and must be handled appropriately. Additional R&D is required to establish an alternate photolysis unit to overcome the problem.

Cont'd

This report is organized into four volumes: Volume I presents the final report on the performance of the Thermal Desorption/Ultraviolet Photolysis process for use in decontaminating soil containing Herbicide Orange/Dioxin. Volume II contains appendices A through O. Volume III contains appendix P. Volume IV contains appendices Q through V.

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PREFACE

This report was prepared for the Air Force Engineering and Services Center, Engineering and Services Laboratory, Tyndall AFB, Florida, under Job Order Number (JON) 2103 9027. The principal contractor, EG&G Idaho, Inc., is the prime contractor for the Department of Energy, Idaho National Engineering Laboratory. The major subcontractor for the project is the International Technologies Corporation, Knoxville, Tennessee.

This report is organized into four volumes: Volume I presents the final report on the performance of the Thermal Desorption/Ultraviolet Photolysis process for use in decontaminating soil containing Herbicide Orange/dioxin. Volume II contains appendices A through O. Volume III contains appendix P. Volume IV contains appendices Q through V.

Other contributors to this report include: E. Alperin, W.A. Prop, A.E. Grey, D.L. Miller, H.J. Welland, D.J. Harvego, H.D. Williams, and G. Peterson.

This report has been reviewed by the Public Affairs Office (PAO) and is releasable to the National Technical Information Services (NTIS). At NTIS, it will be available to the general public, including foreign nationals.

This report has been reviewed and approved for publication.

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~~LIST OF~~ APPENDICES

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APPENDIX Q

CREOSOTE CHROMATOGRAM SUPPLIED BY SUPELCO, INC.

The documents contained in this appendix were published according to their own internal style, which deviates from ESL format. They have, therefore, been published without editing.

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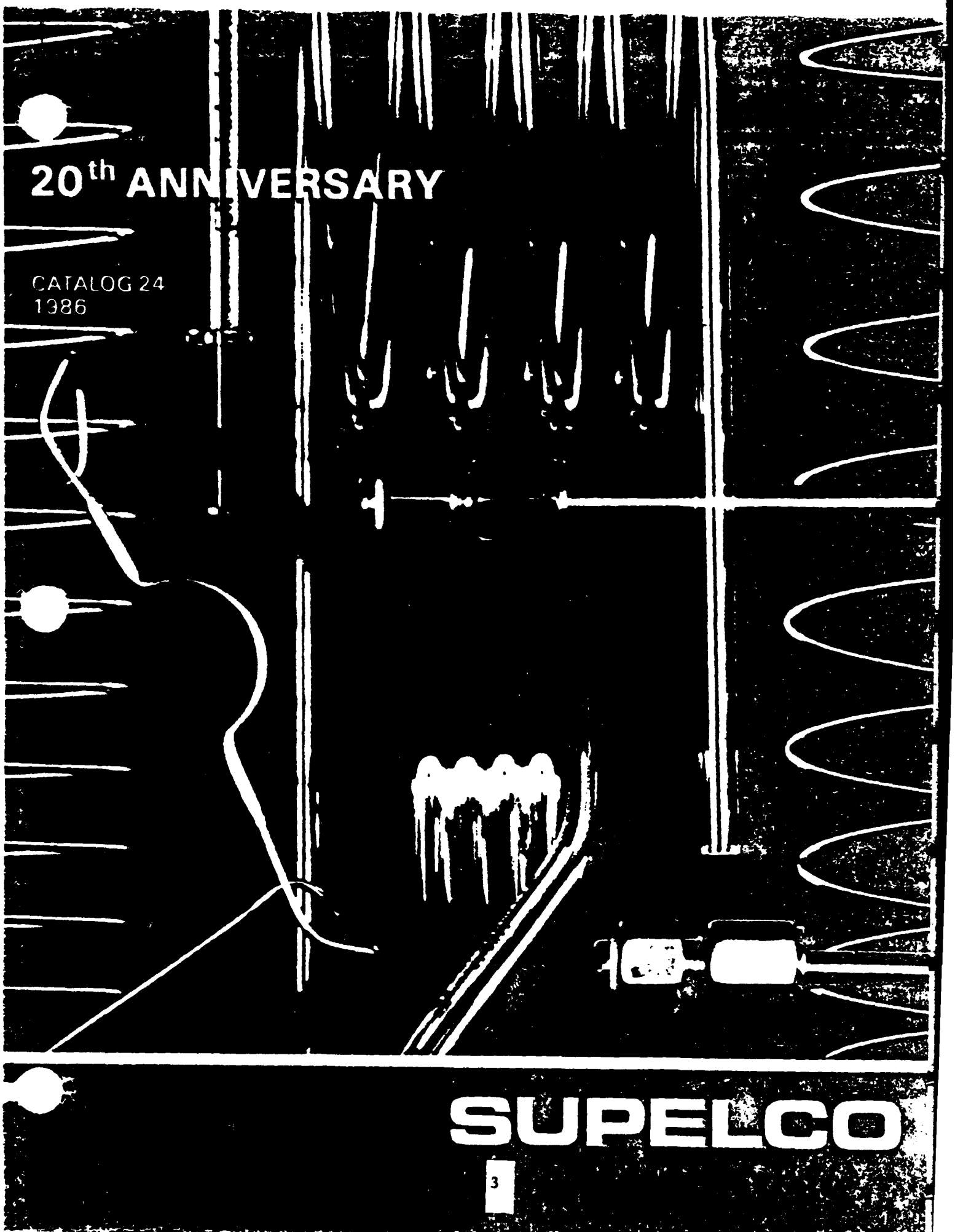
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High Boiling Mixtures

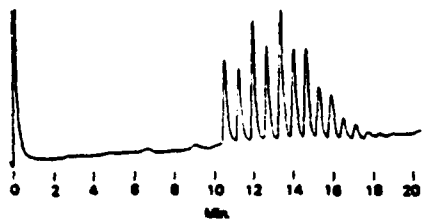
Stable Phases for Separating High Boiling Mixtures

arations of very high boiling mixtures glycerides, cholesteryl esters, etc.) require a stationary phase with good stability at temperatures above 300°C.

For packed columns, Dexsil® 300, a low polarity carborane silicone, can be used at up to 450°C with negligible bleed. Short (12" to 18") columns of 1% Dexsil are recommended for many types of samples (Figures A - D). For complex hydrocarbon mixtures, 3% Dexsil is suggested (Figure E). For more details, request Bulletins 743 and 755.

SPB-1 capillary columns (bonded SE-30 phase) offer a stable baseline and thermal stability to 320°C. We recommend you use a 0.75mm ID column and on-column injection (flash vaporization) when analyzing high boiling mixtures. This will prevent the discrimination that occurs with splitter systems. Under these conditions, branched hydrocarbons (short peaks) and n-alkanes (tall peaks) in a wax sample are well separated (Figure F). You can easily install and use a 0.75mm ID column in a packed column GC (see "Wide Bore Capillary Columns" in the index or request Bulletin 814 for more details).

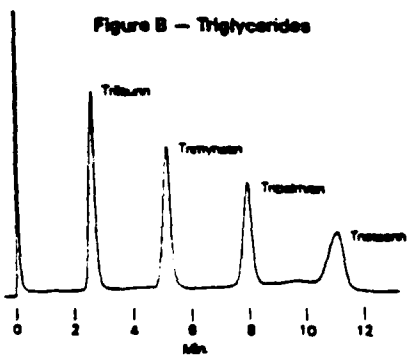
Figure A — Pentaerythritol Esters



1% Dexsil 300 on 100/120 Supelcoport, 18" x 1/8" SS, Col. Temp.: 125° to 300°C at 8°C/min., Inlet Temp.: 325°C, Det. Temp.: 350°C, Flow Rate: 20ml/min., N_2, Sample: 1 µl chloroform containing 10 µg esters.

Packing: Cat. No. 1-1972, $81/20g

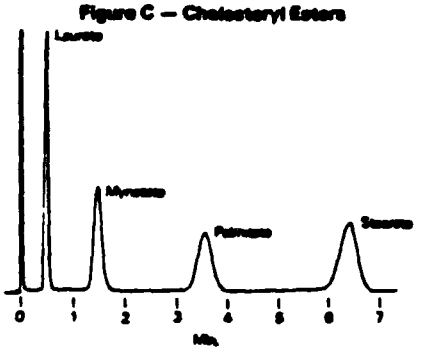
Figure B — Triglycerides



1% Dexsil 300 on 100/120 Supelcoport, 18" x 1/8" SS, Col. Temp.: 275° to 350°C at 8°C/min., Inlet Temp.: 325°C, Det. Temp.: 350°C, Flow Rate: 20ml/min., N_2, Sample: 1 µl chloroform containing 1 µg each triglyceride.

Packing: Cat. No. 1-1972, $81/20g

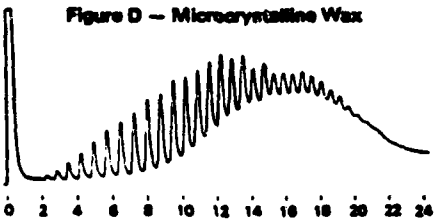
Figure C — Cholesteryl Esters



1% Dexsil 300 on 100/120 Supelcoport, 18" x 2mm ID glass, Col. Temp.: 300° to 350°C at 8°C/min., Inlet Temp.: 325°C, Det. Temp.: 350°C, Flow Rate: 40ml/min., N_2, Sample: 1 µl chloroform containing 1 µg each ester.

Packing: Cat. No. 1-1972, $81/20g

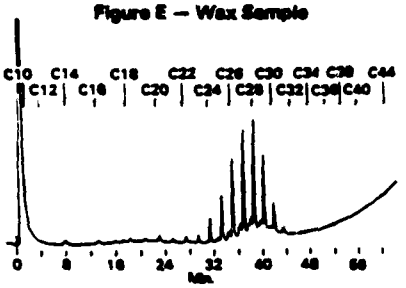
Figure D — Microcrystalline Wax



1% Dexsil 300 on 100/120 Supelcoport, 18" x 1/8" SS, Col. Temp.: 175° to 350°C at 8°C/min., Inlet Temp.: 325°C, Det. Temp.: 350°C, Flow Rate: 20ml/min., N_2, Det.: FID, Sens.: 16×10^{-11} AFS, Sample: 1 µl chloroform, containing 30 µg wax.

Packing: Cat. No. 1-1972, $81/20g

Figure E — Wax Sample



3% Dexsil 300 on 100/120 Supelcoport, 6' x 1/8" SS, Col. Temp.: 100° to 360°C at 4°C/min., Flow Rate: 20ml/min., N_2, Sample: 1 µl chloroform containing 30 µg wax.

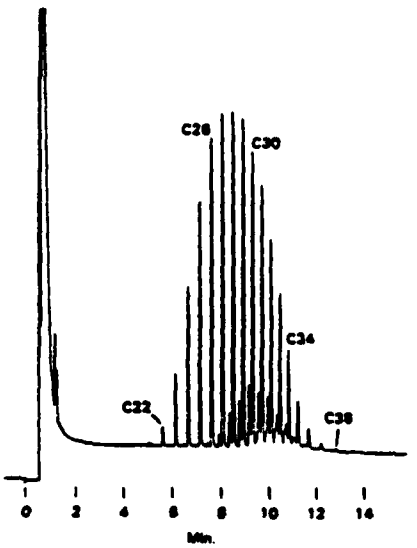
Packing: Cat. No. 1-1973, $107/20g

Additional Packing for High Boiling Aromatics

1-2132 10% SP-2250 on 100/120 Supelcoport, 20g $62

For packed columns, see "Columns" in the Index.

Figure F — Wax Sample Injected onto a 0.75mm ID Column in a Packed Column GC



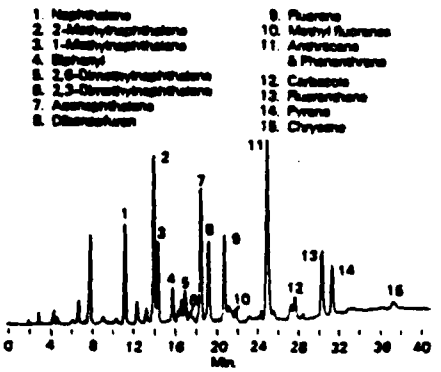
SPB-1 wide bore capillary column, 30m x 0.75mm ID, 1.0 µm film, Col. Temp.: hold 2 min. at 180°C, then to 320°C at 16°C/min., and hold 15 min., Inj. & Det. Temp.: 350°C, Flow Rate: 15cc/min., He (flow controlled), Det.: FID, Sens.: 4×10^{-10} AFS, Sample: 2 µl of a commercial wax in undecane, 130 µg/µl, direct injection.

Column: Cat. No. 2-3755, $250

High Boiling Aromatics

We recommend 10% SP-2100 methyl silicone for separating high boiling aromatics (Figure G). A 10% SP-2250 methyl phenyl silicone is also useful for such separations. For more details, request Bulletin 743.

Figure G — Creosote



10% SP-2100 on 100/120 Supelcoport, 10' x 1/8" SS, Col. Temp.: 100° to 300°C at 8°C/min., Flow Rate: 20ml/min., N_2, Det.: FID, Sample: 0.1 µl.

Packing: Cat. No. 1-1989, $62/20g

APPENDIX R

BATTELLE COLUMBUS LABORATORIES
ANALYTICAL METHODOLOGIES AND RESULTS FOR
DIOXIN/FURANS IN NCBC SOIL AND SOLVENT SAMPLES

Exhibit 1 Battelle Columbus Laboratories Analytical Methodology and Results for Dioxin/Furans in NCBC Soil Samples

Exhibit 2 Battelle Columbus Laboratories Analytical Methodology for Dioxin/Furans in NCBC Solvent Samples

The documents contained in this appendix were published according to their own internal style, which deviates from ESL format. They have, therefore, been published without editing.

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APPENDIX R, EXHIBIT 1

BATTELLE COLUMBUS LABORATORIES ANALYTICAL METHODOLOGY AND RESULTS FOR DIOXIN/FURANS IN NCBC SOIL SAMPLES

INTRODUCTION

This Exhibit[a] describes the analytical procedures used to determine the levels of polychlorinated dibenzo-p-dioxins (PCDDs) and polychlorinated dibenzofurans (PCDFs) in three soil samples and three QA/QC samples which were submitted by EG&G Idaho, Inc. Two of these soil samples, feedstock sample IT-NCBC-R1-01 and treated soil sample IT-NCBC-R1-02, were from the ITC soil desorption testing at the NCBC. The other soil sample was from the Huber testing at the NCBC which was concurrent with the ITC testing. These data are included because of the QA/QC program interactions. The specific levels of 2,3,7,8-tetrachlorodibenzo-p-dioxin (2,3,7,8-TCDD) and 2,3,7,8-tetrachlorodibenzofurans (2,3,7,8-TCDF) as well as the congener class concentrations of the tetrachloro- through octachloro-PCDD/PCDF classes were determined.

ANALYTICAL METHODOLOGY

Extraction

Ten g of each of the three samples, as well as the duplicate and native spike samples, were weighed and transferred to Soxhlet extractors. Sample number IT-NCBC-R1-01 was used as the duplicate and HU-NCBC-R2-02 was used as the native spike. These five samples and the method blank were spiked with 25.0 ng each of three isotopically labeled internal

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a. Information is referenced from Battelle Columbus Laboratories, Final Report on Determination of Polychlorinated Dibenzo-p-dioxins and Polychlorinated Dibenzofurans in Soil Samples which was prepared for EG&G Idaho, Inc., dated May 21, 1986.

standards: 2,3,7,8-TCDD-$^{13}C_{12}$, 2,3,7,8-TCDF-$^{13}C_{12}$, and OCDD-$^{13}C_{12}$. The samples were then Soxhlet extracted for 18 hours using benzene.

Extract Cleanup

The benzene extracts were concentrated to approximately 5 ml using three stage Snyder columns, diluted with 5 ml of hexane, and transferred to multilayered columns containing activated silica gel, 44 percent concentrated sulfuric acid on silica gel, and 33 percent 1M sodium hydroxide on silica gel. The columns were rinsed with 70 ml of hexane and the entire eluates were collected. The purpose of these columns was to remove acidic and basic compounds from the extracts as well as oxidizable materials.

The benzene/hexane eluates were concentrated using a gentle stream of nitrogen gas and solvent exchanged into hexane. The hexane solutions were chromatographed through columns containing approximately 1 gm of activated basic alumina using hexane/methylene chloride (97:3, v/v), and hexane/methylene chloride 1:1, v/v) as elution solvents. The 1:1 hexane/methylene chloride eluates were collected, concentrated to near dryness, and dissolved in 20 µl of n-decane containing 10 ng of 1,2,3,4-TCDD-$^{13}C_{12}$ which was used as an absolute recovery standard. The solutions were stored at 0 °C and protected from light until analyzed.

Analysis

The extracts were analyzed and quantified for PCDD/PCDF using combined capillary column gas chromatography/high resolution mass spectrometry (HRGC/HRMS). The HRGC/HRMS consisted of a Carlo Erba Model 4160 gas chromatograph interfaced directly into the ion source of a VG Model 7070 mass spectrometer. The chromatographic column was a 60M DB-5 fused silica column using helium carrier gas at a flow velocity of 25 cm/sec. The mass spectrometer was operated in the electron impact (EI) ionization mode at a mass resolution of 9,000-12,000 (M/ M, 10 percent valley definition). The

operating parameters of the HRGC/HRMS are summarized in Table R-1.1. All HRGC/HRMS data were acquired by multiple-ion-detection (MID) using a VG Model 2035 Data System. The exact masses that were monitored are shown in Table R-1.2.

Quality Assurance

The operation of the HRGC/HRMS was evaluated each day by analyzing standard mixtures of PCDD/PCDF isomers. These consisted of native and isotopically labeled isomer mixtures used to determine response factors, mixtures of selected PCDD/PCDF isomers to evaluate the stability of the chromatographic elution windows, and TCDD isomer mixtures to evaluate isomer resolution. The mass accuracy of the MID unit was evaluated at least every four hours by focusing selected ion masses from perfluorokerosene (PFK) and correcting the slope to account for minor variations. Mass focus stability was assured by the use of a reference PFK "lock mass" to correct for any mass focus drift.

A method blank and a native spiked sample were processed during the extraction and cleanup of the samples. The results of these analyses are summarized in Table R-1.3. The raw mass spectral data, areas and heights, are presented in Table R-1.4. The method blank was free from PCDD/PCDF contamination except for trace levels of HpCDD and OCDD. Background levels of higher chlorinated dioxins are periodically observed in low level PCDD/PCDF analyses. The average native spike recoveries were within approximately 6.5 percent of the spiked value.

Quantification

The PCDF/PCDD isomers were quantified by comparing the sum of the two ion masses monitored for each class to the sum of the two ion masses monitored for the corresponding internal standard. The 2,3,7,8-TCDF-$^{13}C_{12}$ was used to quantify the tetrachlorodibenzofuran isomers, the 2,3,7,8-TCDD-$^{13}C_{12}$ was used to quantify the tetrachlorodibenzodioxins and the pentachloro- and hexachloro-dioxin and furan isomers. The OCDD-$^{13}C_{12}$ was used for the heptachloro- and

octachlorodioxins and furans. Experimental relative response factors were obtained by analyzing a test mixture which contained representatives of the tetrachloro- through octachloro-PCDD/PCDF classes. These response factors were included in all calculations used to quantify the data. The response factors were calculated by comparing the sum of the areas of the two ion masses monitored for each congener class to the corresponding internal standard ion masses. The experimental response factors were:

	Data File		
Analyte	591018	591109	Average
TCDF	1.0620	0.9982	1.0301
TCDD	1.0270	1.1209	1.0740
PCDF	0.9463	1.0413	0.9938
PCDD	0.3942	0.4622	0.4282
HxCDF	0.9669	1.0277	0.9973
HxCDD	0.4425	0.4893	0.4659
HpCDF	2.0288	2.4330	2.2309
HpCDD	3.0541	3.0823	3.0682
OCDF	0.9205	1.0532	0.9869
OCDD	1.0568	1.0776	1.0672

Internal Standard RRF Relative to
1,2,3,4-TCDD$^{13}C_{12}$ for Recovery Calculations

TCDF-$^{13}C_{12}$	0.9695
TCDD-$^{13}C_{12}$	1.1-49
OCDD-$^{13}C_{12}$	0.2491

The formula used for quantifying the PCDD/PCDF isomers was:

$$\text{Level (ppb)} = \frac{\text{Areas of Quantification Masses x Amount of Internal Standard (ng)}}{\text{Areas of Internal Std. Masses x Resp. Factor x Wt. Sample (g)}}$$

The criteria that were used to identify PCDD and PCDF isomers were:

(1) Simultaneous responses at both masses

(2) Chlorine isotope ratios within ±15 percent of the theoretical values

(3) Chromatographic retention times within windows determined by analyses of standards

(4) Signal to noise ratio equal to or greater than 2.5 to 1.

The 2,3,7,8-TCDF/TCDD isomers included the additional criterion that they elute within ±2 seconds of their isotopically labeled analogs. A limit of detection was calculated for samples in which a particular chlorination class was not detected. The formula used was:

$$\text{Limit of Detection (ppb)} = \frac{\text{Hts of Quant. Masses x Amt. Int. Std. (ng) x 2.5}}{\text{Hts. of Int. Std. Masses x Resp. Factor x Wt. Sample (g)}}$$

Results

The levels of PCDD/PCDF determined in the samples are summarized in Table R-1.3. Analysis of sample number IT-NCBC-R1-01 in duplicate indicated the presence of 2,3,7,8-TCDD at the levels of 165 ppb and 170 ppb. Since the level of native 2,3,7,8-TCDD in the sample is approximately 70 times higher than the level of the internal standard, it is possible that the response of the ion source of the mass spectrometer was not linear. The sample was reinjected with a 0.1 µl injection size (rather than 2.0 µl). This analysis indicated the level of 2,3,7,8-TCDD to be 220 ppb, however, it is possible that the actual level is even higher. In an attempt to obtain a more representative value for the level of native

material in this sample, 100 ppb of 2,3,7,8-tetrachlorodibenzo-p-dioxin-$^{37}Cl_4$ (2,3,7,8-TCDD$^{37}Cl_4$ was spiked into the sample extract. The amount of 2,3,7,8-TCDD$^{37}Cl_4$ was then determined relative to 2,3,7,8-TCDD$^{13}C_{12}$. The sample was diluted by a factor of ten and the native 2,3,7,8-TCDD was quantified based on the 2,3,7,8-TCDD-$^{37}Cl_4$. As in the 0.1 µl injection of the nondiluted sample, this set of analysis indicated the level of native material to be 220 ppb. The formulas used for this calculation were:

$$\text{Stnd } R_f\ ^{13}C_{12}/^{37}Cl_4 = \frac{\text{Area } ^{13}C_{12} \text{ Quant Masses in Stnd x Amt. } ^{37}Cl_4 \text{ (ng)}}{\text{Area } ^{37}Cl_4 \text{ Quant Masses in Stnd x Amt. } ^{13}C_{12} \text{ (ng)}}$$

$$\text{Sample } R_f\ ^{13}C_{12}/^{37}Cl_4 = \left[\frac{\text{Area } ^{13}C_{12} \text{ Quant Masses in Stnd x Amt. } ^{37}Cl_4 \text{ (ng)}}{\text{Area } ^{37}Cl_4 \text{ Quant Masses x Amt. } ^{13}C_{12}/\text{(ng)}}\right] x$$

$$\left[1/(\text{Stnd } R_f\ ^{13}C_{12}/^{37}Cl_4)\right]$$

and

$$\text{Native Conc} = \left[\frac{\text{Area Native Quant Masses x Amt. } ^{37}Cl_4 \text{ (ng)}}{\text{Area } ^{37}Cl_4 \text{ Quant Mass x Wt. Sample (g)}}\right] x$$

$$\left[1/(\text{Stnd } R_f \text{ Native}/^{37}Cl_4)(\text{Sample } R_f\ ^{13}C_{12}/^{37}Cl_4)\right]$$

Table R-1.4 lists the area data and the concentrations used in these calculations. The reconstructed ion chromatograms for these three data files (Stnd, Lower Sensitivity, and Higher Sensitivity) are contained in

the section of this report that is labeled "IT-NCBC-R1-01$^{37}Cl_4$-Spike". The only alternative available to obtain a reliable value for the amount of native material in this sample involves the additional cost of repeating the extraction using a smaller sample size (1 g versus 10 g). At this time, after several conversations with the staff at EG&G Idaho, it was decided that it would not be appropriate under the time and cost restraints to proceed any further with this sample.

For those samples in which a particular chlorination class was not detected, a detection in parts-per-billion (ppb) is listed in Table R-1.3. The height and area data used to calculate the concentrations and detection limits can be found in Table R-1.5.

The percent recoveries of the internal standards in each sample and the chlorine isotope ratios for isomers or isomer classes that were detected are reported in Tables R-1.6 and R-1.7, respectively. The formula used to calculate the percent recoveries was:

$$\text{Percent Recovery} = \frac{(\text{Area of Quant. Masses of Stnd}) \times (\text{Amt. 1,2,3,4,-TCDD-}^{13}C_{12}) \times 100}{(\text{Area of Quant. Masses of 1,2,3,4-TCDD-}^{13}C_{12}) \times (\text{Amt. Stnd}) \times R_f}$$

where R_f is relative to 1,2,3,4-TCDD-$^{13}C_{12}$.

Single Ion Current Chromatograms

The single ion current chromatograms for the samples, standards, and decane analyses are included in the appropriately denoted sections of the referenced Battelle report (see footnote at beginning of this appendix). They are assembled in analysis order and are cross referenced by the table that prefaces each section. The data files are six digit numbers with the first two numbers denoting the instrument logbook in which the analysis is recorded. The third and fourth numbers denote the page in the logbook and

the fifth and sixth numbers denote the line on which the entry was made. All information pertaining to the extraction and workup of the samples can be found in Battelle Laboratory Record Book Number 40196. The GC/MS acquisition parameters can be found in Laboratory Record Book Number 41270.

TABLE R-1.1 HRGC/HRMS OPERATING PARAMETERS

Mass Resolution	9,000-12,000 (M/ΔM, 10 percent valley definition)
Electron Energy	70 eV
Accelerating Voltage	6,000 volts
Source Temperature	200 °C
Preamplifier Gain	5×10^{-8} volts/amp
Electron Multiplier Gain	$\sim 10^{6}$
Transfer Line Temperature	280 °C
Column	DB-5 60M
Injector Temperature	300 °C
Column Temperature -- Initial	160 °C hold for 2 min
Column Temperature -- Program	20 °C/min to 240 °C hold for 30 min 20 °C/min to 320 °C hold for 20 min
Carrier Gas	Helium
Flow Velocity	~25 cm/sec
Injection Mode	Splitless
Injection Volume	2 µL

TABLE R-1.2 EXACT MASSES USED FOR THE DETERMINATION OF PCDD AND PCDF

Compound	Accurate Mass		Theoretical Isotope Ratio Mass 1/Mass 2
	Mass 1	Mass 2	
Tetrachlorodibenzo-p-dioxins	319.8965	321.8936	0.77
Tetrachlorodibenzofurans	303.9016	305.8987	0.77
Pentachlorodibenzo-p-dioxins	355.8546	357.8517	1.54
Pentachlorodibenzofurans	339.8597	341.8567	1.54
Hexachlorodibenzo-p-dioxins	389.8156	391.8127	1.23
Hexachlorodibenzofurans	373.8207	375.8178	1.23
Heptachlorodibenzo-p-dioxins	423.7766	425.7737	1.03
Heptachlorodibenzofurans	407.7817	409.7788	1.03
Octachlorodibenzo-p-dioxins	457.7377	459.7347	0.88
Octachlorodibenzofurans	441.7428	443.7398	0.88
Tetrachlorodibenzo-p-dioxin-$^{13}C_{12}$	331.9367	333.9338	0.77
Tetrachlorodibenzofuran-$^{13}C_{12}$	315.9418	317.9389	0.77
Octachlorodibenzo-p-dioxin-$^{13}C_{12}$	469.7779	471.7749	0.88

TABLE R-1.3 DATA FOR TETRA THROUGH OCTA CHLORODIBENZOFURANS AND DIOXINS IN EG&G IDAHO SOIL SAMPLES

	Method Blank Assuming 10 Gms			IT-NCBC-R1-1 9.8 Gms			IT-NCBC-R1-1-DUP 9.8 Gms			IT-NCBC-R1-02 10.0 Gms			HU-NCBC-R2-02 9.95 Gms			HU-NCBC-R2-02-I 10.0 Gms	
	Number Isomers	Conc ppb	DL ppp	Number Isomers	Conc ppb	DL ppb	Number Isomers	Conc ppb	DL ppb	Number Isomers	Conc ppb	DL ppb	Number Isomers	Conc ppb	DL ppb	Number Isomers	Conc ppb
2,3,7,8-TCDF	0	ND	0.001	1	4.5	00	1	5.2	--	C	ND	0.02	0	ND	0.01	1	0.95
Total TCDF	0	ND	0.001	9	11.1	--	10	13.5	--	0	ND	0.02	0	ND	0.01	1	0.95
2,3,7,8-TCDD	0	ND	0.01	1	165[a]	--	1	170[a]	--	0	ND	0.04	0	ND	0.04	1	1.1
Total TCDD	0	ND	0.01	3	170[a]	--	3	170[a]	--	1	0.09	--	0	ND	0.04	1	1.1
Total PCDF	0	ND	0.002	3	0.2	--	6	1.5	--	0	ND	0.01	0	ND	0.01	1	0.92
Total PCDD	0	ND	0.003	3	4.6	--	4	5.7	--	0	ND	0.01	0	ND	0.03	1	0.89
Total HxCDF	0	ND	0.001	3	0.2	--	3	0.2	--	0	ND	0.01	0	ND	0.01	1	0.65
Total HxCDD	0	ND	0.002	5	0.7	--	5	1.0	--	0	ND	0.02	0	ND	0.02	1	1.2
Total HpCDF	0	ND	0.004	1	0.1	--	1	0.2	--	0	ND	0.02	0	ND	0.02	1	0.94
Total HpCDD	2	0.02	--	2	0.5	--	2	0.8	--	0	ND	0.02	0	ND	0.05	1	1.2
OCDF	0	ND	0.01	1	0.2	--	1	0.3	--	0	ND	0.07	0	ND	0.07	1	1.2
OCDD	1	0.2	--	1	2.4	--	1	2.7	--	1	0.2	--	0	ND	0.4	1	1.6

a. A 0.1 µl injection indicated 220 ppb. Actual value may be even higher. See text.

TABLE R-1.4 AREA AND CONCENTRATION DATA FOR 2,3,7,8-TCDD- Cl_4 SPIKED SAMPLE IT-NCBC-R1-01 (9.8 GMS)

	Amount 2,3,7,8-TCDD-$^{37}Cl_4$	Amount 2,3,7,8-TCDD-$^{13}C_{12}$	Amount 2,3,7,8-TCDD Native	320 Area	322 Area	328 Area	332 Area	334 Area
R_f Standard 579313	80 ng	80 ng	80 ng	16832.94	20368.01	20816.14	10609.81	13078.88
IT-NCBC-R1-01 Lower sensitivity 579315	980 ng	25 ng	--	994.84	1245.01	1931.16	--	--
IT-NCBC-R1-01 Higher sensitivity 579317	980 ng	25 ng	--	--	--	20296.4	196.53	227.92

TABLE R-1.5 HEIGHT AND AREA DATA FOR EG&G IDAHO SOIL SAMPLES

Sample Number	2,3,7,8-TCDF		Total TCDFs				2,3,7,8-TCDD		Total TCDDs			
	304 Area	306 Area	304 Ht.	304 Area	306 Ht.	306 Area	320 Area	322 Area	320 Ht.	320 Area	322 Ht.	322 Area
IT-NCBC-R1-01	1954	2592	--	4792	--	6405	84112	110505	--	85487	--	112301
IT-NCBC-R1-02	ND	ND	0.36	ND	0.55	ND	ND	ND	0.72	41	0.81	49
HU-NCBC-R2-02	ND	ND	0.21	ND	0.29	ND	ND	ND	0.59	ND	0.61	ND
IT-NCBC-R1-01 0.1 µl							15434	18900				
Method Blank	ND	ND	0.15	ND	0.17	ND	ND	ND	0.92	ND	1.29	ND
IT-NCBC-R1-01-Dup	2374	3080	--	6189	--	7869	101832	134395	--	103589	--	136840
HU-NCBC-R2-02-M	497	658	--	497	--	658	629	726	--	629	--	726

Sample Number	Total PCDFs				Total PCDDs				Total HxCDFs				Total HxCDDs			
	340 Ht.	340 Area	342 Ht.	342 Area	356 Ht.	356 Area	358 Ht.	358 Area	374 Ht.	374 Area	376 Ht.	376 Area	390 Ht.	390 Area	392 Ht.	392 Area
IT-NCBC-R1-01	--	160	--	104	--	1301	--	866	--	116	--	96	--	178	--	160
IT-NCBC-R1-02	0.15	ND	0.11	ND	0.12	ND	0.1	ND	0.22	ND	0.11	ND	0.14	ND	0.2	ND
HU-NCBC-R2-02	0.07	ND	0.34	ND	0.18	ND	0.16	ND	0.11	ND	0.14	ND	0.15	ND	0.17	ND
Method Blank	0.22	ND	0.25	ND	0.12	ND	0.31	ND	0.15	ND	0.06	ND	0.17	ND	0.14	ND
IT-NCBC-R1-01-Dup	--	1250	--	746	--	1933	--	1255	--	121	--	98	--	323	--	262
HU-NCBC-R2-02-M	--	666	--	415	--	271	--	179	--	437	--	325	--	396	--	284

TABLE R-1.5 (CONCLUDED)

Sample Number	Total HpCDFs				Total HpCDDs				OCDF				OCDD			
	408 Ht.	408 Area	410 Ht.	410 Area	424 Ht.	424 Area	426 Ht.	426 Area	442 Ht.	442 Area	444 Ht.	444 Area	458 Ht.	458 Area	460 Ht.	460 Area
IT-NCBC-R1-01	--	25	--	22	--	143	--	157	--	19	--	20	--	219	--	252
IT-NCBC-R1-02	0.18	ND	0.12	ND	0.09	ND	0.19	ND	0.17	ND	0.25	ND	--	14	--	16
HU-NCBC-R2-02	0.1	ND	0.11	ND	0.42	ND	0.37	ND	0.08	ND	0.29	ND	1.03	--	0.98	--
Method Blank	0.34	ND	0.35	ND	--	52	--	48	0.32	ND	0.19	ND	--	156	--	165
IT-NCBC-R1-01-Dup	--	41	--	36	--	276	--	258	--	26	--	29	--	293	--	314
HU-NCBC-R2-02-N	--	282	--	243	--	476	--	420	--	140	--	150	--	207	--	216

Sample Number	Internal Standards: 2,3,7,8-TCDF-$^{13}C_{12}$				2,3,7,8-TCDD-$^{13}C_{12}$				OCDD-$^{13}C_{12}$				1,2,3,4-TCDD-$^{13}C_{12}$	
	316 Ht.	316 Area	318 Ht.	318 Area	332 Ht.	332 Area	334 Ht.	334 Area	470 Ht.	470 Area	472 Ht.	472 Area	332 Area	334 Lit.
IT-NCBC-R1-01	140	1136	164	1373	140	1236	169	1541	23	240	21	234	466	636
IT-NCBC-R1-02	111	952	171	1551	107	1048	146	1374	20	197	18	203	382	533
HU-NCBC-R2-02	99	830	157	1385	84	771	118	1061	14	162	19	205	352	461
IT-NCBC-R1-01 0.1 µl						174		221						
Method Blank	877	7840	1243	11047	788	8181	1024	10340	222	1931	225	2170	3112	4088
IT-NCBC-R1-01-Dup	152	1314	152	1263	156	1471	193	1841	22	265	25	268	504	603
HU-NCBC-R2-02-N	146	1218	193	1728	132	1267	180	1681	26	297	27	329	516	673

TABLE R-1.6 RECOVERIES OF INTERNAL STANDARDS

Sample Number	TCDF-$^{13}C_{12}$	TCDD-$^{13}C_{12}$	OCDD-$^{13}C_{12}$
IT-NCBC-R1-01	94	91	69
IT-NCBC-R1-02	113	96	70
HU-NCBC-R2-02	116	84	75
Method Blank	108	93	91
IT-NCBC-R1-01-Dup	96	108	77
HU-NCBC-R2-02-N	102	90	85

TABLE R-1.7 CHLORINE ISOTOPE RATIOS (THEORETICAL RATIO) FOR EG&G IDAHO, TASK 9 SOIL SAMPLES

Sample Name	2,3,7,8-TCDD (0.77)	Total TCDD (0.77)	2,3,7,8-TCDF (0.77)	Total TCDF (0.77)	PCDD (1.54)	PCDF (1.54)	HxCDD (1.23)	HxCDF (1.23)	HpCDD (1.03)	HpCDF (1.03)	OCDD (0.88)	OCDF (0.88)
IT-NCBC-R1-01	0.76	0.76	0.75	0.75	1.50	1.54	1.11	1.21	0.91	1.14	0.87	0.95
IT-NCBC-R1-02	--	0.84	--	--	--	--	--	--	--	--	0.88	--
MU-NCBC-R2-02	--	--	--	--	--	--	--	--	--	--	--	--
Method Blank	--	--	--	--	--	--	--	--	1.08	--	0.95	--
IT-NCBC-R1-01-Dup	0.76	0.76	0.77	0.79	1.54	1.68	1.23	1.23	1.07	1.14	0.93	0.90
MU-NCBC-R2-02-N	0.87	0.87	0.76	0.76	1.51	1.60	1.39	1.34	1.13	1.16	0.96	0.93

APPENDIX R, EXHIBIT 2

BATTELLE COLUMBUS LABORATORIES
ANALYTICAL METHODOLOGY FOR DIOXIN/FURANS
IN NCBC SOLVENT SAMPLES

INTRODUCTION

This Exhibit[a] describes the analytical procedures used to determine the level of 2,3,7,8-tetrachlorodibenzo-p-dioxins (2,3,7,8-TCDD) in a solvent sample submitted by EG&G Idaho, Inc. This sample, IT-NCBC-R2-04, is the treated solvent (Soltrol^{R}) from the ITC photolysis test performed at the NCBC.

ANALYTICAL METHODOLOGY

Extraction

Initially, this sample was added to methylene chloride in an attempt to solvent/solvent extract the 2,3,7,8-TCDD from the treated Soltrol^{R} solvent. The two solvents were completely miscible, which made this type of extraction impossible. Subsequently, 100 ml of the solvent sample was placed in a 500 ml round bottom flask and then put on a Buchi Rotary Evaporator that was fitted with a dry ice/acetone trap (-79 °C) and a vacuum pump that was capable of pressures down to 6 torr. At 50 °C there was no appreciable evaporation. At 95 °C, there was some evaporation; however, decomposition of the sample was also evident by the appearance of a black particulate and the solvent turning dark brown. The next method that was attempted was an alumina column cleanup. Fifty ml of the sample that had been spiked with internal standards was added to a 50 g column of alumina and rinsed with the appropriate solvents to elute the 2,3,7,8-TCDD. After

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a. Information is referenced from Battelle Columbus Laboratories, Final Report on Determination of 2,3,7,8-Tetrachlorodibenzo-p-dioxin in Soil and Soltrol Samples from Johnson Island, which was prepared for EG&G Idaho, Inc., dated July 15, 1986.

the appropriate cleanup procedures were performed, the column effluent was concentrated down to near dryness and brought back up in decane that contained 1,2,3,4-TCDD$^{13}C_{12}$ as a recovery standard. Gas chromatography/mass spectrometry (GC/MS) analysis of these samples indicated that the 2,3,7,8-TCDD was not recovered. In a final attempt, the sample was treated as a transformer oil sample and passed through macroalumina columns. Two grams of sample were spiked with 20.0 ng 2,3,7,8-TCDD-$^{13}C_{12}$ and 4.0 ng 2,3,7,8-TCDD-$^{37}Cl_4$ and then divided into six equal fractions. Each 1/3 g fraction was passed through a different alumina column. The final effluents were combined and successfully analyzed as one sample by high resolution mass spectrometry (HRMS).

Extract Cleanup

The extract was concentrated to approximately 5 mL using three-stage Snyder columns, diluted with 5 mL of hexane, and transferred to multilayered columns containing activated silica gel, 44 percent concentrated sulfuric acid on silica gel, and 33 percent 1M sodium hydroxide on silica gel. The columns were rinsed with 70 mL of hexane and the entire eluates were collected. The purpose of these columns was to remove acidic and basic compounds from the extracts as well as oxidizable materials.

The eluate was concentrated using a gentle stream of nitrogen gas and solvent-exchanged into hexane. The hexane solution was chromatographed through columns containing approximately 1 g of activated basic alumina using hexane/methylene chloride (97:3, v/v), and hexane/methylene chloride (1:1, v/v) as elution solvents. The 1:1 hexane/methylene chloride eluate was collected, concentrated to near dryness, and dissolved in 20 µL of n-decane. The solution was stored at 0 °C and protected from light until analyzed.

Analysis

The solvent sample was analyzed using combined capillary column gas chromatography/high resolution mass spectrometry (HRGC/HRMS). The HRGC/HRMS consisted of a Carlo Erba Model 4160 gas chromatograph interfaced directly into the ion source of a VG Model 7070 mass spectrometer. The chromatographic column was a 60M DB-5 fused silica column using helium carrier gas at a flow velocity of 25 cm/sec. The mass spectrometer was operated in the electron impact (EI) ionization mode at a mass resolution of 9,000-12,000 (M/ΔM, 10 percent valley definition). The operating parameters of the HRGC/HRMS are summarized in Table R-2.1. All HRGC/HRMS data were acquired by multiple-ion-detection using a VG Model 2035 Data System. The exact masses that were monitored are 319.8965 and 321.8936 for native 2,3,7,8-TCDD while 331.9367 and 333.9338 were monitored for 2,3,7,8-TCDD-$^{13}C_{12}$.

Quality Assurance

Chromatographic column performance, including peak shape and TCDD isomer resolution, was evaluated at the start and end of the work shift by analyzing a mixture of TCDD isomers obtained from the U.S. EPA through EG&G containing 2,3,7,8-TCDD, 1,2,3,4-TCDD, 1,4,7,8-TCDD, 1,2,3,7-TCDD, 1,2,3,8-TCDD, 1,2,7,8-TCDD, and 1,2,6,7-TCDD. Decane analyses were performed by injecting 2 µl of decane into the gas chromatograph/mass spectrometer (GC/MS) to demonstrate the lack of carryover in the syringe, chromatographic column, and injector.

Table R-2.2 lists the response factors for each of the five levels, triplicate analysis of the calibration standards as well as the area ratios and relevant ratios that were used to generate the plotted concentration calibration curves (Figures R-2.1 and -2.2). The quantification for the HRMS analysis was calculated using the response factor from a single point calibration of a 25 ppb standard that was run with the analysis of the sample extracts. Table R-2.3 contains a chronological list of all the analyses performed with the solvent sample.

The mass accuracy of the MID unit for HRMS was evaluated at least every four hours by focusing selected ion masses from perfluorokerosene (PFK) and correcting the slope to account for minor variations. Mass focus stability was assured by the use of a reference PFK "lock mass" to correct for any mass focus drift.

The method blanks that were prepared and analyzed along with the samples did not contain any native 2,3,7,8-TCDD above the HRMS detection limit of 0.06 ppb for the solvent sample.

Qualification

The 2,3,7,8-TCDD was quantified by comparing the sum of the areas for the two ion masses monitored for the native material to the areas monitored for the internal standard.

The formula used for quantifying the 2,3,7,8-TCDD was:

$$\text{Level} = \frac{\text{Areas of Quant. Masses x Amt. of Int. Std (ng)}}{\text{Areas of Int. Std. Masses x Resp. Factor x Wt. Sample (g)}}$$

The criteria that were used to identify the 2,3,7,8-TCDD were:

(1) Simultaneous responses at both quantitation masses and m/z = 257.

(2) Chlorine isotope ratios within ± 15 percent of the theoretical values.

(3) Chromatographic isotope ratios within ± 2 seconds of the labeled internal standard.

(4) Signal to noise ratio equal to or greater than 2.5 to 1

A limit of detection was calculated for samples in which 2,3,7,8-TCDD was not detected. The formula used was:

$$\text{Level} = \frac{\text{Hts. of Quant. Masses x Ampt. Int. Std. (ng) x 2.5}}{\text{Hts of Int. Std. Masses x Resp. Factor x Wt. Sample (g)}}$$

RESULTS

Analysis of the solvent sample using a 25 ppb standard for a one point calibration indicated the presence of native 2,3,7,8-TCDD at 31 ppb. The raw mass spectral data, areas and heights for the HRMS analyses are presented in Table R-2.4.

Single Ion Current Chromatograms

The chromatograms for the HRMS analysis of the solvent sample, method blank, standard, decane blank and column performance analyses are included in the high resolution section of this report. They are assembled in analysis order and are cross referenced by the table that prefaces each section. The data files are six digit numbers with the first two numbers denoting the instrument logbook in which the entry was made. All information pertaining to the extraction and workup of the samples can be found in Battelle Laboratory Record Book Nos. 41162 and 40079. The GC/MS acquisition parameters can be found in Laboratory Record Book Nos. 41180 and 41498.

TABLE R-2.1. HRGC/HRMS OPERATING PARAMETERS

Mass Resolution	9,000-12,000 (M/ΔM, 10 percent valley definition)
Electron Energy	70 eV
Accelerating Voltage	6,000 volts
Source Temperature	200 °C
Preamplifier Gain	5×10^{-8} volts/amps
Electron Multiplier Gain	$\sim 10^{6}$
Transfer Line Temperature	300 °C
Column	DB-5 60M
Injector Temperature	300 °C
Column Temperature--Initial	160 °C hold for 3 min
Column Temperature--Program	8 °C/min to 220 °C hold for 45 min 15 °C/min to 320 °C hold for 20 min
Carrier Gas	Helium
Flow Velocity	~25 cm/sec
Injection Mode	Splitless
Injection Volume	1-2 µl

TABLE R-2.2. CALIBRATION CURVE SUMMARY

File Name	NRRF	SRRF	A_{st}/A_{is}	A_{sur}/A_{is}
564517STD01	1.0982	1.1357	0.2196	0.0693
564518STD01	1.0257	1.0413	0.2052	0.0635
564519STD01	1.0149	1.1228	0.2029	0.0684
Mean	1.0463	1.0999		
RSD	4.3%	4.7%		
564522STD05	0.9195	1.1141	0.9196	0.1384
564523STD05	0.9112	1.1290	0.9113	0.1401
564524STD05	0.9115	1.0465	0.9116	0.1302
Mean	0.9141	1.0965		
RSD	0.5%	4.0%		
564526STD25	0.8864	0.9951	4.4323	0.2217
564527STD25	0.8806	1.0029	4.4034	0.2228
564528STD25	0.9237	1.0289	4.6190	0.2296
Mean	0.8969	1.0090		
RSD	2.6%	1.8%		
564529ST100	0.8093	NP	16.188	--
564530ST100	0.8007	NP	16.016	--
564531ST100	0.8094	NP	16.190	--
Mean	0.8065			
RSD	0.6%			
564619ST200	0.8936	NP	35.683	--
564620ST200	0.9092	NP	36.370	--
564621ST200	0.8756	NP	35.027	--
Mean	0.8928			
RSD	1.9%			
Mean	0.9113	1.0685		
RSD	9.5%	4.8%		
Range NRRF	0.8202 to 1.0024			
Range SRRF	0.9616 to 1.1753			

NRRF = Native Relative Response Factor

SRRF = Surrogate Relative Response Factor

A_{st}/A_{is} = Area standard/Area internal standard

A_{sur}/A_{is} = Area surrogate/Area internal standard

NP = Not Present

Figure R-2.1 Native relative response factor.

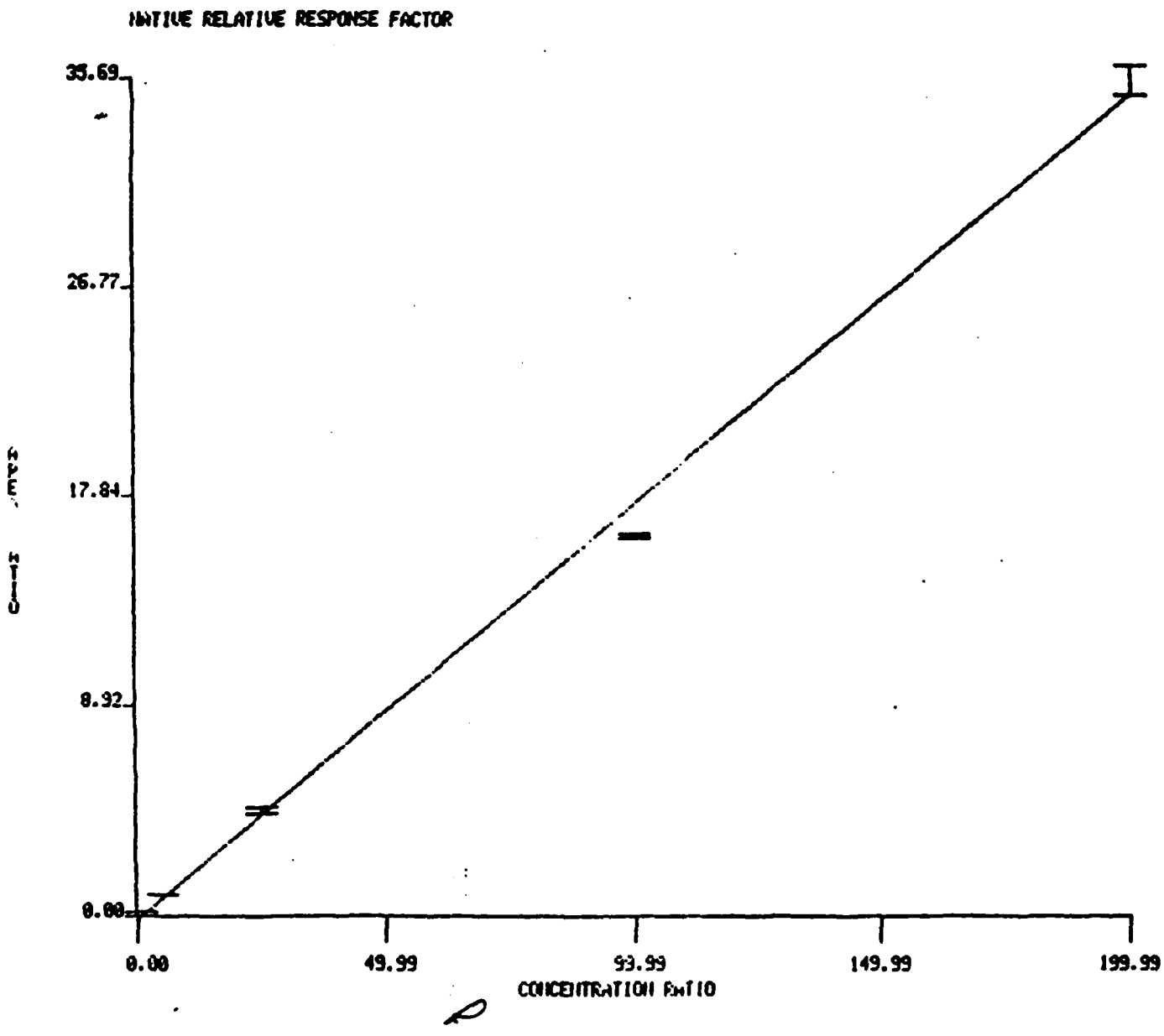

Figure R-2.1A Data for NRRF calibration curve.

NATIVE RELATIVE RESPONSE FACTOR

X-VALUES	Y-VALUES		
1.0000	0.2196	0.2052	0.2029
5.0000	0.9196	0.9113	0.9116
25.0000	4.4323	4.4034	4.6190
100.0000	16.1880	16.0160	16.1900
200.0000	35.6829	36.3700	35.0270

X-VALUE	Y-VALUE	STD DEV	RSD%	RES. E.	R.R.E.
DATA WITH RESPECT TO THE Y-VALUES					
1.0000	0.2093	0.0091	4.32	0.0074	0.0007
5.0000	0.9142	0.0048	0.51	0.0039	0.0004
25.0000	4.4849	0.1171	2.60	0.0956	0.0084
100.0000	16.1314	0.0999	0.61	0.0816	0.0071
200.0000	35.6933	0.6716	1.88	0.5484	0.0478
DATA WITH RESPECT TO THE REGRESSION LINE					
1.0000	0.2093	0.2664	127.30	0.2175	0.0190
5.0000	0.9142	0.2660	29.08	0.2172	0.0190
25.0000	4.4849	0.3414	7.61	0.2788	0.0243
100.0000	16.1314	1.6127	9.99	1.3168	0.1147
200.0000	35.6933	1.0118	2.83	0.8262	0.0720

A SLOPE OF 0.17629 GIVES AN INTERCEPT OF -0.18442
A SLOPE OF 5.67217 GIVES AN INTERCECT OF 1.04609
THE DATA HAS A CORRELATION COEFFICIENT OF 0.99873

Figure R-2.2 Surrogate relative response factor.

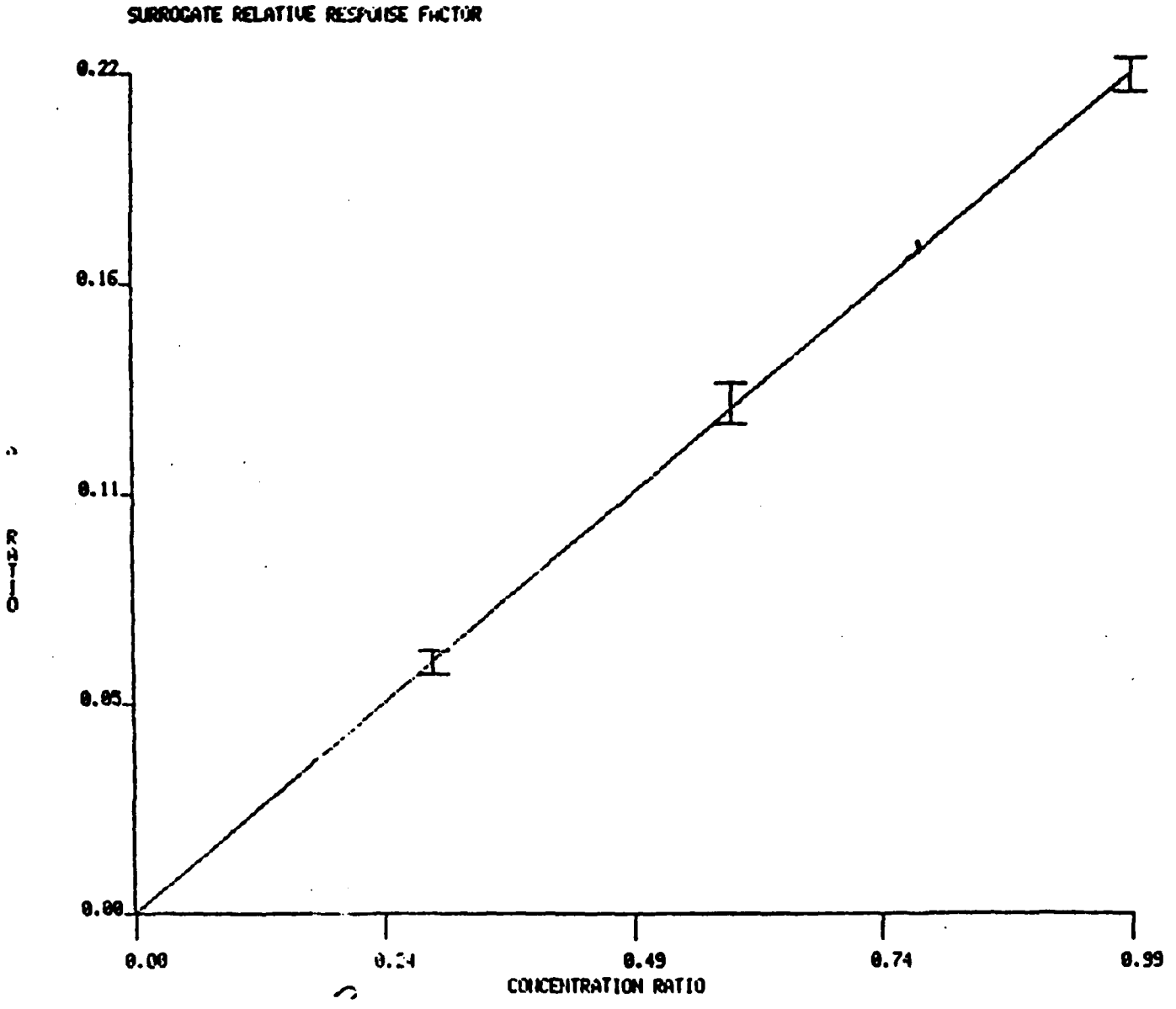

Figure R-2.2A Data for SRRF calibration curve.

SURROGATE RELATIVE RESPONSE FACTOR

X-VALUES	Y-VALUES		
[illegible]	0.0693	0.0635	[illegible]
0.6000	0.1334	0.1401	0.1302
1.0000	0.2217	0.2228	[illegible]

X-VALUE	Y-VALUE	STD DEV	RSD%	REL. E.	P. E.

DATA WITH RESPECT TO THE Y-VALUES

0.3000	0.0671	0.0032	4.65	0.0048	0.0310
0.6000	0.1363	0.0053	3.88	0.0075	0.0525
1.0000	0.2247	0.0043	1.90	0.0061	0.0425

DATA WITH RESPECT TO THE REGRESSION LINE

0.3000	0.0671	0.0033	4.78	0.0046	0.0319
0.6000	0.1363	0.0055	4.00	0.0078	0.0541
1.0000	0.2247	0.0044	1.92	0.0062	0.0428

A SLOPE OF 0.22497 GIVES AN INTERCEPT OF 0.00018
A SLOPE OF 4.44498 GIVES AN INTERCECT OF -0.00081
THE DATA HAS A CORRELATION COEFFICIENT OF 0.99993

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TABLE R-2.3 CHRONOLOGICAL LIST OF ALL SOLVENT ANALYSIS PERFORMED

Data File Name	EG&G Idaho Sample Number	Battelle Sample Number	Analysis Time[a]
613208	IT-NCBC-R2-4	41162-28-02	12:04
613209	CC3	40079-75-28	13:07
613210	PC	40079-73-28	14:15
613211	DECANE	DECANE	16:30
613212	IT-METHOD BLANK	41162-28-3	17:34

a. All analyses were performed on July 1, 1986.

TABLE R-2.4 HIGH RESOLUTION DATA FOR 2 G SOLTROL[R] SOLVENT SAMPLE ANALYSIS

	Sample[a]			
Parameter	IT-NCBC-R2-04	CC3-25 PPR STD[b]	PC-Column PERF	Method Blank
2,3,7,8-TCDD (ppb)	31	25	2.1	<0.06[c]
Relative ion abundance				
320/322	0.79	0.79	0.82	1.42
332/334	0.81	0.83	0.81	0.79
Surrogate % accuracy	92	100	103	120
20 area (height)	34397	13985	488	(0.92)
322 area (height)	43705	17507	595	(0.65)
328 area (height)	6225	1435	536	3351
332 area (height)	11607	2961	1174	6350 (291)
334 area (height)	14339	3586	1457	7990 (378)
320/322 ratio	0.79	0.79	0.82	1.42
332/334 ratio	0.81	0.83	0.81	0.79

a. Analyses performed with GC/MS instrument ID 7070-E on July 1, 1986.

b. Native relative response factor and surrogate relative response factor calculated on this standard: NRRF = 0.9590 and SRRF = 0.9756.

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APPENDIX S

REVIEW/EVALUATION OF ANALYTICAL RESULTS FOR TD/UV PHOTOLYSIS PROCESS VERIFICATION SAMPLES AT NCBC

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The documents contained in this appendix were published according to their own internal style, which deviates from ESL format. They have, therefore, been published without editing.

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REVIEW/EVALUATION OF THE ANALYTICAL RESULTS FOR THE IT PROCESS VERIFICATION SAMPLES

Introduction

Chemical Sciences of EG&G Idaho, Inc., had the responsibility for reviewing and evaluating all of the analytical data from the International Technology Corporation (IT) process technology demonstration at the NCBC site. California Analytical Laboratories, Inc., (CAL) was selected as the subcontract laboratory for analysis of all of the process verification samples collected during the IT demo. These samples were shipped to CAL from the NCBC site in several batches. Samples were received at the laboratory on June 15, June 21, and June 29, 1985.

The analytical results were transmitted by CAL in several submittals. The various submittals were as follows:

Item	Date of Submittal	Description
1	9/10/85	Preliminary reports on polychlorinated dibenzo-p-dioxins and dibenzofurans
2	1/21/86	Data summaries and information on analytical protocols
3	1/31/86	Results of sample submitted for EP Tox Test
4	3/11/86	Additional data and information plus clarification of data summaries. (This information was provided in response to requests by EG&G Idaho made during meetings with CAL on March/4-5/86).

5	3/21/86	Additional information, including a revised inorganics analysis data package, some reanalysis results for specific samples and additional supporting information. (This information was also provided in response to EG&G Idaho requests made during the 3/4-5/86 meetings with CAL.)
6	4/22/86	Results of the reanalysis of five samples for semivolatile organics.

All of the data submitted by CAL pertaining to the IT demo was included in the EG&G Idaho review/evaluation process. After the samples were submitted to CAL, two to four months elapsed before any analyses were performed. Thus, sample holding times as dictated by the EPA were exceeded by wide margins.

In addition, there were other problems with various portions of the data, which will be documented and discussed in detail. Furthermore, at the time there was no universally accepted data review protocol for the polychlorinated dibenzo-p-dioxins (PCDDs) and polychlorinated dibenzofurans (PCDFs) other than for the isomer specific analysis of 2,3,7,8-tetrachlorodibenzo-p-dioxin (2,3,7,8-TCDD).

Therefore, because of the problems and limitations of the data and also the absence, in some cases, of applicable data review protocols to validate the results, it was deemed inappropriate to attempt to validate the results in the strict sense used by the EPA. Instead, the results were reviewed and evaluated from three perspectives if (a) the appropriate analytical protocols were used and applied correctly, (b) if the various calculations were correct, and (c) if the results were consistent and made sense.

The summary of the results of the EG&G Idaho review/evaluation process is presented in the following sections. The discussion has been broken down by the class of analysis performed (e.g., inorganics, volatile organics).

Inorganic Results

Samples from the IT Corporation demonstration project were submitted to CAL for inorganic element analysis, including cyanide, on June 15 and 21, 1985. The methods used for analysis were taken from the U.S. EPA Contract Laboratory Program (CLP) protocols. The specific instrumental techniques used are specified on the data reporting sheets.

On January 21, 1986, analytical results for inorganic elements were submitted to EG&G Idaho for review. A review of the data showed many calculational errors. These errors were pointed out to CAL, and corrected data sheets were prepared on March 19, 1986. All calculations on the new data sheets were correct, and from the data submitted it appears that proper analytical procedures were used.

The inorganic analyses were performed on October 28, 1985, approximately four months after the samples were received. During this period of time, the samples were stored at ambient temperature and without preservatives.

The CLP protocol states that samples for cyanide analysis are to be stored at 4 C and the maximum holding time is 14 days. For mercury, the maximum holding time is 30 days. For all other metals, the maximum holding time is six months. The protocol also states that for mercury and all other metals, the pH of the sample is to be adjusted to 2 with nitric acid for sample preservation. No differentiation is made in the protocol between liquid and solid samples.

Based on the above, the values for metals and cyanide cannot be validated. However, they can be used as a general guide for evaluating their fate in the IT process.

An additional area of concern is with the spike sample recovery. Each sample was spiked with a known amount of each element to be determined. The percent recovery of the spiked elements gives a measure of the

extraction efficiency. The percent recovery of each spiked element should fall within 75 and 125 percent of the amount added to the sample. A review of the data shows that 71 spike recovery results, representing 30.3 percent of the values reported, were outside this target window. The position of CAL is that these questionable spike recovery values are normal and are completely acceptable to the EPA. EG&G Idaho contacted the organization performing review of inorganic analytical results for the EPA and was informed that currently no action is taken if the spike recovery values are outside the stated limits. However, EG&G Idaho feels that it is indicative of questionable analytical techniques.

Volatile Organic Compounds

The various soil and carbon filter samples were analyzed for volatile organic compounds. The analytical procedures were taken from the CLP protocol and based on EPA Method 624.

The samples submitted to CAL were received by that laboratory on June 15 and 21, 1985. The samples were stored at ambient temperature and extracted on September 13 and 17, 1985, approximately three months after receipt. In addition, the samples for volatile organic analysis were taken about three weeks after the containers had been opened to take samples for semivolatile organic components.

The CLP protocol states that samples for volatile organic analysis must be protected from the light and refrigerated at 4 C from the time of receipt until they are extracted. The extraction and analysis are to be done within ten days of sample receipt.

The CLP protocol further states that a 4- or 5-point calibration curve is to be prepared for each instrument used in the analysis. This calibration curve is necessary to determine the linearity of response for that instrument. No evidence could be found that any calibration curve had been prepared.

Based on all of the above, results obtained for volatile organic components are not considered valid.

Semivolatile Organic Compounds

The semivolatile organic compounds were analyzed using the CLP protocol, which is based on EPA Method 625. The samples submitted to CAL were received at that laboratory on June 15 and 21, 1985. The extraction for semivolatile organic components was performed on August 23 and 27, 1985. Two extractions were performed on September 3, 1985. This is approximately 2-1/2 months after the samples were received.

The CLP protocol states that samples for organic analysis must be protected from the light and refrigerated at 4 C from the time of receipt until extracted. Solid samples must be extracted within ten days of receipt and the extract analyzed within 40 days of extraction. The samples in question were stored at ambient temperature for the 2-1/2 months prior to extraction.

The analysis contract required that semivolatile organic compounds be analyzed to 1 ppm. It appears that, in general, CAL adhered to this requirement. However, one sample (IT-NCBC-R2-09) which is a sample from the front half of the first carbon bed did not meet this requirement and required reanalysis. The reanalysis was performed by taking the sample extract from a previous analysis and concentrating the extract from approximately 0.54 gm/1 mL to 0.54 gms/0.5 mL. While that should double the concentration and lower the detection limit by half, the reported detection limit was lowered by a factor of four. There was no evidence that sample injection size had been increased. An additional point of concern is that the detection limit is based on the peak height versus background noise level for any given component. It is therefore highly improbable that each component would have the same detection limit. However, the factor of four improvement in detection level was reported for all compounds.

Based on all of the above, the reported data cannot be validated. Because the semivolatile compounds are less volatile, the length of storage time and storage conditions would be less critical than for the volatile organic compounds. Therefore, the values can possibly be used as a guide for a partial evaluation of the IT process.

Pesticides/PCB Analysis

The pesticide analysis included the chlorinated insecticides and herbicides as well as the polychlorinated biphenyls. These components were determined using the CLP protocol which is based on EPA Method 608. One method covers both classes of compounds.

The samples for pesticide/PCB analysis were extracted on August 23 and 27, 1985. There is one notable exception, sample IT-NCBC-R4-02 was extracted on June 21, 1985, the day the sample was received. However, the sample extract was not analyzed until September 18, 1985, which is well beyond the 40-day limitation specified in the CLP protocol. The same storage conditions and time restrictions for sample extraction and analysis exist for the pesticide/PCB samples as for the semivolatile organic material. Like the other organics, there is no evidence of any instrument calibration curves having been prepared.

Based on the above, the reported pesticide/PCB values cannot be validated. However, like the semivolatile organic components and for the same reason, the reported data can possibly be used as a guide for partial evaluation of the IT process.

General Comments

The IT process consists of essentially two separate processes. The first process is a pyrolysis of the contaminated soil to vaporize out any organics, including dioxin, that may be present. The vaporized components are trapped in a scrubber solvent. The soil has now been decontaminated.

The second phase or process is photolysis of the scrubber solvent to degrade dioxin and other hazardous components which may be present to innocuous substances.

The samples analyzed by CAL were primarily the soils before and after pyrolysis and the carbon filter bed for trapping any stray contaminants in the system off-gas. Therefore, that part of the system concerned with soil pyrolysis can be partially evaluated from the data received.

Three samples of scrubber solvent after photolysis were submitted to CAL for analysis (IT-NCBC-R1-04, IT-NCBC-R2-04 and IT-NCBC-R3-04). The scrubber solvent from the first and third runs were analyzed for metal content, but no organic analyses were performed. Therefore, evaluation of the photolysis system cannot be made.

Dioxin and Dibenzofuran Results

Two types of analyses were performed for the polychlorinated dibenzo-p-dioxins (PCDDs) and polychlorinated dibenzofurans (PCDFs): a) total isomer class content for tetra, penta, and hexachlorinated PCDDs and PCDFs and b) 2,3,7,8-TCDD isomer specific. The review methodology was to evaluate all data in terms of applicable ion ratios, retention times, and signal-to-noise ratios to determine if the analytical results were correctly interpreted.

The isomer specific 2,3,7,8-TCDD data were examined and evaluated using the same criteria applied during the soil sampling and analysis program conducted previously for the USAF at the NCBC site. The criteria are detailed in the EPA document for reviewing 2,3,7,8-TCDD analytical results (Reference 1), and the criteria are listed in the Annex to this Appendix. The results of the evaluation will be discussed in two parts, the isomer class analyses and the isomer specific analysis. The isomer class analyses will be discussed first. CAL, in their original proposal to EG&G Idaho, proposed using EPA Method 8280 (as modified by EMSL-Las Vegas) to perform the isomer class analyses.

CAL stipulated that extraction methodologies would probably require modification due to the types of sample matrices involved and this was understood by EG&G Idaho. However, it was not felt that the modification in extraction methodology would significantly alter the remainder of the analytical technique. Upon receipt of the data from CAL and the letter describing the data (January 21, 1986) CAL stated, "The dioxin and furan analyses were performed according to methods acceptable to EPA." No mention of EPA Method 8280 was made.

Based upon prior knowledge of 8280 and a review of CAL's isomer class data, it was apparent that a method other than 8280 was performed. The comment must be made that Method 8280 has been under revision for several years and that the final validated 8280 method was not completed and released by EMSL-Las Vegas until March of 1986.

EG&G Idaho obtained a copy of the Method 8280 from EMSL-Las Vegas for further review. Upon review of this document, the use of multipoint calibration curves were confirmed, which CAL did not perform. Other differences in procedures were noted between Method 8280 and the method CAL used. However, many of these differences are due to the multiple versions of 8280 in existence. The use of multipoint calibration curves, however, has been mandatory in all versions.

The main point of concern deals with the use of single concentrations of analytical standards to determine response factors used in quantification calculations. Method 8280 stipulates multilevel calibration standards be used to determine response factors. This is an important consideration when a wide range of concentration values are anticipated as was the case of the IT samples.

As opposed to Method 8280, CAL ran a single point standard on a daily basis to determine response factors for the various analytical parameters. The standard was a mixture of polychlorinated dioxins and furans which contained the following compounds:

2,3,7,8-TCDD

2,3,7,8-$^{13}C_{12}$-TCDD

2,3,7,8-$^{37}Cl_4$-TCDD

1,2,3,7,8-P_5-CDD

1,2,3,7,8-$^{13}C_{12}$-P_5CDD

1,2,3,4,7,8-H_xCDD

1,2,3,4,7,8-$^{13}C_{12}$-H_xCDD

1,2,3,4,7,8-$^{13}C_{12}$-TCDF

1,2,3,7,8-P_5-CDF

1,2,3,7,8-$^{13}C_{12}$-P_5CDF

2,3,4,7,8,-$^{13}C_{12}$-P_5CDF

1,2,3,4,7,,,8-H_xCDF

1,2,3,4,7,8-^{13}C-H_xCDF

CAL furnished the raw chromatograms of the standard analyses as well as their calculation sheets. These data were reviewed and calculations checked to verify numerical accuracy. Standards were either obtained commercially or manufactured by CAL. Sources of all standards were documented by CAL. The analyses were conducted using high resolution gas chromatography/low resolution mass spectrometry. The isomer class content analyses were conducted using a DB-5 fused silica capillary GC column of 60 meters in length. The temperature program used was to ramp the GC column temperature from 190 degrees C to 305 degrees C at a rate of 10 C/min.

The following ions were monitored to determine the presence of PCDDs and PCDFs as well as to provide information for quantification:

Compound	Nominal Mass 1	Nominal Mass 2	Theoretical Isotope Ratio Mass 1/Mass 2
TCDD	320	322	0.77
TCDD-$^{13}C_{12}$	332	334	0.77
P_5CDD	354	356	0.617
P_5CDD-$^{13}C_{12}$	366	368	0.617
H_xCDD	390	392	1.235
H_xCDD-$^{13}C_{12}$	402	404	1.235
TCDF	304	306	0.77
TCDF-$^{13}C_{12}$	316	318	0.77
P_5CDF	338	340	0.617
P_5CDF-$^{13}C_{12}$	350	352	0.617
H_xCDF	372	374	0.514
H_xCDF-$^{13}C_{12}$	386	390	2.858

In addition to these ions, ions indicative of polychlorinated diphenylethers (possible environmental contaminants which can be misidentified as polychlorinated dibenzofurans) were monitored.

The normal accepted practice is that the experimental isotope ratios should be within +15 percent of the theoretical value in order to be considered a positive indicator of the presence of a PCDD or PCDF. Upon reviewing CAL's data and documentation, it was hard to determine if this practice was followed for the isomer class data. CAL's supporting documentation dealt primarily with 2,3,7,8-TCDD analysis with little devoted to specific QA/QC criteria for the PCDD/PCDF analyses. Several of the IT samples were determined to have internal standards with isotope ratios slightly outside of the +15 percent boundary. It should be noted that as the number of analyses increases it becomes more probable that some of the criteria will

be marginal or slightly outside acceptable limits. Concern was exhibited only on those instances where exceptionally wide deviations from the +15 percent were determined.

The following IT samples were analyzed for total tetra through hexachlorinated PCDD and PCDF content:

IT-NCBC-R1-01	IT-NCBC-R1-02	IT-NCBC-R1-03
IT-NCBC-R1-04	IT-NCBC-R1-5-06	IT-NCBC-R1-5-10
IT-NCBC-R1-09	IT-NCBC-R1-09A	IT-NCBC-R2-01
IT-NCBC-R2-02	IT-NCBC-R2-03	IT-NCBC-R2-09
IT-NCBC-R2-09A	IT-NCBC-R3-01	IT-NCBC-R3-02
IT-NCBC-R3-03	IT-NCBC-R3-04	IT-NCBC-R4-01
IT-NCBC-R4-02	IT-NCBC-R5-01 IT-NCBC-R5-02	
IT-NCBC-R5-09	IT-NCBC-R5-09A	

In addition, a single method blank was analyzed in conjunction with the 23 IT samples. The CAL identification of the method blank was 21413-2MBRXRX indicating that CAL found it necessary to re-extract the method blank twice, apparently in order to meet the required detection limits. This is a cause for concern, since the data for the other method blank extractions was not provided and no explanation was given as to why the re-extractions were necessary. From the data provided, there is no way to correlate when the method blank was extracted. If contamination in the method blanks was present and this was the cause of the re-extractions, it could mean that some of the actual IT samples were, in fact, contaminated through laboratory handling, thus providing false positives. No IT samples were analyzed in duplicate for tetra through hexachlorinated PCDPs and PCDFs. The review of the data also revealed that no IT samples were used as matrices for native spike samples.

The following samples were determined by CAL not to contain PCDDs or PCDFs at or above the reported detection limits: IT-NCBC-R1-02, IT-NCBC-R1-5-10,

IT-NCBC-R1-09, IT-NCBC-R1-09A, IT-NCBC-R2-09A, IT-NCBC-R5-09, IT-NCBC-R5-09A, and the method blank.

Sample IT-NCBC-R1-02, appears to be positive for 2,3,7,8-TCDD based upon the isomer class data (CAL's original data sheet reports a value of 0.42 ppb). CAL apparently changed this value to a "not detected" based on the results of a re-extracted aliquot of this sample that was submitted to isomer specific analysis. The isomer specific analysis showed a result of not detected at a level of 0.076 ppb. The fact that the isomer specific analysis showed not detected does not explain away the apparent positive in the isomer class data. It is possible that the difference in results is due to carry-over from a previous sample or to laboratory contamination of the sample.

Sample IT-NCBC-R1-09 has an area ratio of 0.97 reported for the $P_5CDD\text{-}^{13}C_{12}$ internal standard. This value is well outside of the acceptable range of 0.524 to 0.710. This does not change the result of "not detected."

Based on an examination of the data, it appears that the area of the M/Z 366 peak may be enhanced by a neighboring peak resulting in the higher 366/368 ratio. However, since only M/Z 368 is used in calculating the detection limit, the fact that the ratio is off does not impair the calculated detection limit. Sample IT-NCBC-R1-09A displays the same problem as Sample IT-NCBC-R1-09. Sample IT-NCBC-R5-09 also displays the same problem as IT-NCBC-R1-09. Sample IT-NCBC-R5-09A was determined to have two standards with ratios outside of normal limits. They were the $HxCDF\text{-}^{13}C_{12}$ and $P_5CDD\text{-}^{13}C_{12}$ internal standards. In both cases they were marginally outside the ±15 percent limits.

The remainder of the IT samples were reported by CAL to contain chlorinated dioxins or furans. Sample IT-NCBC-R1-01 was determined to have a saturated response for 2,3,7,8-TCDD when analyzed by the isomer class method. This saturation results in an inaccurate quantitative value. The value of 2,3,7,8-TCDD reported by CAL is based upon the re-extraction of a smaller aliquot of this sample and its analysis using the isomer specific method.

An additional comment must be made about this sample. For several of the isomer classes (TCDFs, P_5CFs, and P_5CDDs), it was observed that when the area ratios of the monitored ions for individual isomers were checked, the area ratios were outside of the ±15 percent criteria for positive identification. However, it was determined that the height ratios of the peaks were within ±15 percent. CAL apparently made the decision that it was appropriate to include the peaks when height ratios but not area ratios were within acceptable limits.

Sample IT-NCBC-R1-03 appears to have an incorrect value of P_5CDD reported. The isomers detected at scans 733, 739, and 760 appear to have been identified by CAL as P_5CDDs and the areas used in the calculations (sum of areas = 930352 + 155888 + 407046 = 1493286). The area ratio of the peaks detected in scan 733 is 0.75, which is well outside the acceptable range of 0.524 to 0.710. In addition, the height ratio is outside the acceptable range (0.711). The same is true for the peaks detected at M/Z 739. Only the peaks detected in scan 760 have the correct ratio. As a result of those incorrect identifications, the total P_5CDD value should be 4.3 ppb rather than the 15.7 as reported. The P_5CDF-$^{13}C_{12}$ and P_5CDF-$^{13}C_{12}$ internal standards also displayed isotope ratios outside the ±15 percent limits.

Sample IT-NCBC-R1-5-06 was determined to have a saturated response for 2,3,7,8-TCDD and for an isomer of the P_5CDF isomer class. As mentioned before, saturation results in incorrect quantitative values. A smaller aliquot of this sample was extracted and analyzed for 2,3,7,8-TCDD by the isomer specific method. The original sample extract for the isomer class analysis was diluted and reanalyzed to try and obtain a nonsaturated response for the P_5CDF isomer. This was successful in that a correct isotope ratio could be determined but resulted in extremely low area counts for the internal standards as a result of the dilution. As a result, it should be noted that the P_5CDF value reported should be considered semiquantitative at best. In addition to the saturation problems, the ratio of the HxCDF-$^{13}C_{12}$ internal standard was determined to be 1.86 which is well outside of the acceptable range of 2.429-3.287. As a result,

the HxCDF value should also be considered semiquantitative. Sample IT-NCBC-R2-01 also had a saturated 2,3,7,8-TCDD response for the isomer class analysis).

Sample IT-NCBC-R2-02 was determined by CAL to contain P_5CDF and TCDD. Upon an examination of the raw data, it was determined that the P_5CDF positive identification was based on a peak height ratio rather than a peak area ratio. This practice is questionable and is not the preferred method, particularly due to the fact that all the response factors used in the calculations are based on peak areas and not heights. The value of P_5CDF in this sample should be considered a maximum possible value. A TCDD level of 0.23 ppb was reported for the isomer class analysis of this sample. Upon later analysis, using the 2,3,7,8-TCDD isomer specific method, a value of "not detected" with a detection limit of 0.34 ppb was reported. Since the isomer class analysis is not specific for 2,3,7,8-TCDD sample, IT-NCBC-R2-02 should be considered to have a maximum possible value of 0.23 ppb of 2,3,7,8-TCDD.

Sample IT-NCBC-R2-03 displayed a saturated response for 2,3,7,8-TCDD. The sample was reanalyzed using the isomer specific method. Sample IT-NCBC-R2-09 was determined to contain 0.13 ppb of TCDD based on isomer class analysis results. When this sample was analyzed by the isomer specific method a result of "not detected" for 2,3,7,8-TCDD was found with a detection limit of 0.14 ppb. The 0.13 ppb positive value for this sample should be considered a maximum possible concentration.

Sample IT-NCBC-R3-01 has a saturated 2,3,7,8-TCDD response for the isomer class analysis data. The sample was re-extracted using a smaller sample aliquot and submitted to isomer specific analysis. Sample IT-NCBC-R3-02 was determined to contain a maximum value of 0.11 ppb of 2,3,7,8-TCDD based upon isomer class analysis. Based upon a review of the data, it is felt that this result is marginal due to the signal-to-noise ratio observed. This is further supported by the fact that an additional aliquot of this sample was submitted to isomer specific analysis, and a result of "not detected" was found with a detection limit of 0.084 ppb.

Sample IT-NCBC-R3-03 was determined to have saturated responses for 2,3,7,8-TCDD and for a single P_5CDF isomer (scan 713). The sample was reanalyzed for 2,3,7,8-TCDD using the isomer specific analysis and a smaller sample size. The original isomer class analysis sample extract was diluted and reanalyzed with the result that the saturated peak was confirmed to be a pentachlorinated dibenzofuran, but no requantification was possible due to the dilution of the internal standard. Therefore, the P_5CDF value reported for sample IT-NCBC-R3-03 should be considered semiquantitative. The data review for this sample also showed that the isotope ratio for the HxCDF-$^{13}C_{12}$ internal standard was well outside of acceptable limits (a value of 2.07 was reported, range is 2.429-3.287). An examination of the chromatograms reveals that the ion at M/Z 386 appears to be incompletely resolved from an adjacent peak. The area reported for this ion is used for quantification of the HxCDFs. Due to this fact, the value reported for the HxCDFs should be considered semiquantitative. Sample IT-NCBC-R3-04 exhibits the same problems as the previous sample.

Sample IT-NCBC-R4-01 was determined to have a saturated response for 2,3,7,8-TCDD. The sample was reanalyzed using a smaller aliquot and the 2,3,7,8-TCDD isomer specific method. Sample IT-NCBC-R4-02 was determined to contain low levels of TCDF, P_5CDF and TCDD. While the identification of the presence of TCDF, P_5CDF, and TCDD appear correct, it appears that the positive results may be due to carry-over (either syringe or GC) from the sample analyzed immediately prior (IT-NCBC-R1-5-06). This is further supported by the isomer specific analysis of this sample which returned a result of "not detected" at a detection limit of 0.060 ppb. Extreme care must be taken to ensure that carry-over from sample to sample is prevented. Based upon the time between the injections of these two samples, it does not appear that sufficient time was available to run a solvent blank through the system to help remove the remnants of the sample containing the high levels.

In summary, the review of the isomer class data revealed incorrect isotope ratios for the internal standards in certain cases, assignment of positive identification based on peak-height ratios when peak-area ratios were incorrect (a questionable practice), and multiple instances of peak

saturation, which in many cases were not acknowledged until pointed out to CAL. In addition, instances of possible contamination from sample carry-over were noted.

It should be noted that the examination of CAL's isomer class data was a review and not a validation. At the time when this work was performed, a single, accepted, validated method for the isomer class determination was not available. Because of this, a uniform set of evaluation criteria has not been adopted. The review was aimed at understanding the data and analytical results and any inconsistencies noted. The data provided by CAL indicates trends in the levels of PCDDs and PCDFs present and can be used on a semiquantitative basis to follow the efficiency of the IT process.

Due to the apparent switch from Method 8280, to what appears to be an in-house method, and the confused method of reporting, it was time consuming and difficult to try and examine the data.

CAL also conducted 2,3,7,8-TCDD isomer specific analyses on specified samples and on those samples found to contain 2,3,7,8-TCDD when analyzed for isomer class content. CAL proposed to perform these analyses according to the U.S. EPA CLP method. According to the final report letter (January 21, 1986), this methodology was used with modifications made for extraction of various sample matrices. As stated previously, the data supplied by CAL were reviewed according to the same criteria used during the previous soil sampling and analysis program. Upon the completion of the review, it was apparent that the CLP procedure was not followed. Inconsistencies included:

1) No initial calibration curve established.

2) Incomplete concentration range of standards (100 ppb and 200 standards omitted).

3) Partial scan was not provided until asked for.

4) Incomplete data reporting, including lack of initial calibration, lack of continuing calibration, lack of chronological list of all analyses performed.

5) Nonadherence to protocol concerning PC check standards.

6) Nonadherence to reporting format specified.

The result of this is that all of the isomer specific data for it can be technically considered to be invalid. The data are usable to project trends in the ability of the IT system to decontaminate soil but would not be accepted by the Sample Management Office of the CLP.

In addition to the IT samples, CAL analyzed a series of air filter samples using toluene Soxhlet extraction followed by CAL's in-house 2,3,7,8-TCDD method. As before, these samples were to have been analyzed by the CLP method using suitable extraction modifications. The same deficiencies noted for the IT 2,3,7,8-TCDD samples apply to the air filter samples.

Upon review of the data, it is considered that the results from Samples 1138 and 1140 (which were reported to be 0.14 ppb and 0.11 ppb or 0.03 pg/m^3 and 0.07 pg/m^3, respectively) should be changed to "not detected" (ND), based on signal-to-noise criteria and have detection limits of less than 0.07 pg/m^3 and less than 0.18 pg/m^3, respectively.

In addition to the samples analyzed by CAL, Battelle Columbus Laboratories analyzed the following IT samples:

IT-NCBC-R1-01 IT-NCBC-R1-02

Sample IT-NCBC-R1-01 was analyzed in duplicate. Battelle performed the tetra through hexachlorinated PCDD and PCDF analysis using its in-house methodology (Refer to the attached report for methods and QA/QC criteria). Good agreement was found between the duplicate analyses. The value of 2,3,7,8-TCDD appears to be low compared to other results for this sample. The low result appears to be due to saturation of the ion source of the

mass spectrometer. This conclusion is supported by the fact that a 0.1 ul injection (as opposed to a normal 2 µL injection) of the sample extracts resulted in a higher 2,3,7,8-TCDD value (220 ppb). The results of CAL data compared to Battelle data are given below for sample IT-NCBC-R1-01:

	CAL	Battelle*
Furans		
Tetra (total)	8.0	12.3
2,3,7,8	2.4	4.85
Penta	8.1	0.85
Hexa	0.33	0.2
Dioxins		
Tetra (total)	262	167.5
2,3,7,8	260	170
Penta	0.87	5.15
Hexa	0.62	0.85

*Approx. average of two values

Some differences are apparent. However, these differences may be attributable to difference in standards or sample inhomogeneity. As mentioned before, Battelle also analyzed Sample IT-NCBL-R1-02. A comparison between the CAL analysis and the Battelle analysis is given below:

	CAL	Battelle
Furans		
Tetra (total)	ND (0.045)[(a)]	ND (0.02)
2,7,8	ND (0.045)	ND (0.02)
Penta	ND (0.029)	ND (0.01)
Hexa	ND (0.050)	ND (0.01)
Dioxins		
Tetra (total)	ND (0.076)	0.09
2,3,7,8	ND (0.076)	ND (0.04)
Penta	ND (0.20)	ND (0.01)
Hexa	ND (0.089)	ND (0.02)

(a) Values in parentheses are detection limits in ppb.

The Battelle data were examined using the QA/QC guidelines in the attached report and found to be in compliance.

Battelle also analyzed an aliquot of Sample IT-NCBC-R2-04 using an in-house methodology (see attached report). A value of 31 ppb of 2,3,7,8-TCDD was found. This value represents a maximum value for 2,3,7,8-TCDD due to the fact that a 60 m DB-5 column was used for the analyses. This is a nonisomer specific column for 2,3,7,8-TCDD. An examination of the few data reveals overloading of the GC column which produced peak-splitting. However, this peak-splitting does not appear to have adversely affected the quantification. A method blank was also analyzed and determined to be free of 2,3,7,8-TCDD at or above the reported detection limit.

Conclusions

There are numerous shortcomings and omissions in the analytical data which prevent any of the results from being validated in the strict interpretation of the word. However, the review/evaluation of the data has shown that the results can be used as indicative. Therefore, the results can be used to identify trends and can be used to evaluate the effectiveness of the IT process technology. It must be noted, however, that the use of the results to provide strict quantitative information about the processes is not justified without the additional corroborative information that would be provided by further testing of the IT process.

As noted previously, two samples were analyzed by Battelle. One sample, which was analyzed in duplicate, was an untreated soil sample; i.e., a sample of soil before treatment. The second sample was treated soil. The samples were both analyzed for tetra through hexa chlorinated dioxins and also the corresponding isomer classes of chlorinated dibenzofurans. The results were supported by adequate QA/QC, including the performance of the duplicate analysis noted above. The duplicate results showed good agreement, and all of the Battelle results met the QA/QC criteria as described in their report. Thus, these results are the most valid indication of the PCDD and PCDF levels in both the untreated and treated

soils. There is general agreement between the Battelle results and those obtained by CAL. Agreement is particularly good for the treated soil.

Based on the agreement between the two laboratories and the quality of the Battelle data, it is clear that the PCDD and PCDF results, at least for the soils, may be used to evaluate the effectiveness of the IT process.

References

1. Review of Contractor Data from the IFB WA84-A002 Chemical Analytical Services for 2,3,7,8-Tetrachlorodibenzo-p-dioxin, Environmental Protection Agency, November 20, 1984.

ANNEX

All 2,3,7,8-TCDD isomer specific analytical data were reviewed and evaluated according to the requirements detailed in the EPA document for reviewing 2,3,7,8-TCDD analytical results (Reference 1 of Appendix S). This document was adapted to form the working document used for detailed data review/evaluation. The criteria used to review the analytical data are as follows:

1. To ensure isomer specificity for chromatographic separation, the 2,3,7,8-TCDD must be separated from interfering isomers with no more than a 50 percent valley relative to the 2,3,7,8-TCDD peak.

2. The M/Z 320/322 and 332/334 ratios must be within the range of 0.67 to 0.87.

3. Ions 320, 322, and 257, which are each monitored separately but concurrently, must all be present; and the signals for all three must maximize simultaneously. The signal-to-noise ratio must be 2.5 to 1 or better for all three ions.

4. The signal-to-noise ratio must be 10 to 1 or better for the 332 and 334 ions, which are the ions due to the internal standard.

5. The retention time of the native 2,3,7,8-TCDD must equal (within 3 seconds) the retention time for the isotopically labeled 2,3,7,8-TCDD.

6. Positive results must be confirmed by obtaining partial scan spectra from mass 150 to mass 350 for selected samples.

7. The surrogate standard results must be within ±40 percent of the true value.

8. 2,3,7,8-TCDD must be absent from the blank (both method blanks and field blanks).

9. Overall, a minimum of 80 percent of the reported values must be certified as valid.

10. The analytical laboratory must obtain satisfactory results for any performance audit and performance evaluation samples.

The above validation criteria that refer specifically to native 2,3,7,8-TCDD (the species potentially present as the soil contaminant) only applied to sample results reported with positive 2,3,7,8-TCDD values. These criteria refer to the 320/322 mass ratio value; the simultaneous presence of the 322, 320, and 257 ions; and the 2,3,7,8-TCDD retention time. For samples in which 2,3,7,8-TCDD was absent, the particular criteria above did not apply.

APPENDIX T

BATTELLE COLUMBUS LABORATORIES
PRIORITY POLLUTANT METALS AND CYANIDE
ANALYTICAL RESULTS FOR SIX NCBC SOIL SAMPLES

The documents contained in this appendix were published according to their own internal style, which deviates from ESL format. They have, therefore, been published without editing.

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Battelle
Columbus Laboratories
505 King Avenue
Columbus, Ohio 43201-2693
Telephone (614) 424-6424
Telex 24-5454

August 5, 1985

Mr. W. A. Propp
EG&G Idaho, Inc.
1955 Fremont Avenue
Idaho Falls, Idaho 83415

Dear Mr. Propp:

The six NCBC soil samples received were analyzed for the thirteen priority pollutant metals and cyanide. The procedures used were standard methods generally used for solid waste analysis by the US EPA. A brief description of the sample preparation is given in the attached write up. The analytical results are reported in Table 1. In addition, the QA/QC program applied for these six samples is briefly described. The QC results are given in Table 2. As can be seen from the replicate analyses and spike recovery data, both the reproducibility and the spike recovery are well within ±10% (except for As).

If you have any questions, please call me at (614) 424-4763 or Dr. D. Miller at (614) 424-6490.

Sincerely,

Afaf K. Wensky, Ph.D.
Associate Manager
Center for Analytical and
Structural Chemistry

AKW:ak

Enc.

Ag, As, Be, Cd, Cr, Cu, Ni, Pb, Se, Ti & Zn Analysis

A 5.0 g sample was weighed from the thoroughly mixed content of the jar containing the original sample. The sample was placed in a 150 mL and 5.0 mL of concentrated HNO_3 were added to it. The beaker was placed on a hot plate set at approximately 90°C and left to digest for 3 hours without allowing it to boil. The beaker contents were then evaporated to near dryness prior to the addition of 5.0 mL of concentrated HNO_3. The beaker was placed back on the hot plate and the contents were evaporated to near dryness again. This step was repeated three times after which 5 mL of 1:1 HNO_3:DI H_2O and 7.5 mL DI water were added. The mixture was heated for 15 minutes prior to filtering through white ribbon paper (No. 584) with pulp into a 50 mL volumetric flask. The contents of the volumetric flask were brought to volume using DI water. This solution was analyzed using either Zeeman graphite furnace atomic absorption spectrophotometry (Z-GF-AAS) or inductively coupled argon plasma (ICAP) according to the instructions given in the manufacturer's manual and the wave lengths given in the attached Tables 3 & 4.

Hg Analysis

A 1.0 g sample was weighed from the thoroughly mixed contents of the jar containing the original sample. The sample was then placed in a 125 mL Erlenmeyer flask and to it 10 mL aqua regia solution were added. The flask was placed on a steam bath and heated for approximately 1 hour then diluted to 50 mL with DI water. 2.5 mL concentrated H_2SO_4, 10 mL $KMnO_4$, and 4 mL $K_2S_2O_8$ were added. This solution was heated in a steam bath for approximately 4 hours after which 1 drop of hydroxylamine hydrochloride and 5 mL stannous chloride were added prior to analysis by cold vapor atomic absorption spectrophotometry (CV-AAS) at the wavelength given in the attached Table 3.

Sb Analysis

A 5.0 g sample was weighed from the thoroughly mixed contents of the jar containing the original sample. The sample was placed in a 150 mL beaker and 10 mL aqua regia were added to it. The mixture was placed on a hot plate set at approximately 90°C and left to digest for three hours. The beaker was

removed, cooled and its contents filtered into a 100 mL volumetric flas through a white ribbon (No. 589) paper with pulp. The beaker and the filte were washed with DI water and the washings were added to the volumetric flas DI water was used to bring the volume to 100 mL prior to analysis by Zeem graphite furnace atomic absorption spectrophotometry (Z-GF-AAS) at the wav length given in the attached Table 3.

QA/QC

All the samples were logged into the central laboratory record system and given Battelle numbers prior to distribution to the individual analysts. All the laboratory activities and results were recorded in Laboratory Book No.'s 40602 and 39818. Sample 40196 53-2 was used for both duplicate and spike recovery studies. The spiking was accomplished by adding the spike level given in Table 2 to the soil sample immediately after adding the acid to it. The spiked sample was then taken through the same analytical procedure as for the unspiked sample.

TABLE 1. ANALYTICAL RESULTS FOR THE INORGANIC PRIORITY POLLUTANTS REPORTED IN µg/g SOIL SAMPLE

Battelle Sample Number	Sample Identification	Ag(a)	As(b)	Be(a)	Cd(a)	Cr(a)	Cu(a)	Hg(c)	Ni(a)	Pb(a)	Sb(b)	Se(b)	Tl(b)	Zn(a)	CN(d)
S84295	40196 53-2 (NCBC Clean)	.18	7.4	.17	2.1	15	4.4	<.05	4.8	58	1.3	<0.3	<0.2	44	<.2
S84296	40196 53-3 (NCBC Clean)	<.1	7.3	.20	2.1	15	4.9	<.05	5.0	58	1.3	<0.3	<0.2	56	<.2
S84297	40196 54-12 (B1 Soil)	.19	6.8	.27	1.6	13	7.7	<.05	3.8	42	1.4	<0.3	<0.2	74	<.2
S84298	40196 54-13 (B2 Soil)	1.5	8.0	.40	1.5	14	5.9	<.05	4.0	45	0.4	<0.3	<0.2	150	<.2
S84299	40196 54-14 (B3-Asphalt)	.27	3.4	.33	.90	8.2	3.3	<.05	8.1	23	0.8	<0.3	<0.2	14	<.2
S84300	40196 54-15 (B4-Asphalt)	.10	3.0	.42	1.1	13	4.0	<.05	12	34	2.5	<0.3	<0.2	49	<.2

(a) Determined using ICAP
(b) Determined using Zeeman Graphite Furnace-AAS
(c) Determined using cold vapor-AAS
(d) Determined according to the method in "Standard Methods for Examination of Water and Wastewater," 12th ed., (1965) p. 448-457.

TABLE 2. QC DATA ON SAMPLE 40196 53-2

Analyte	ug/g					
	Replicate-1	Replicate-2	Average	Spike Added	Amount Found	Percent Recovery
Ag	.18	<.10	--	10	9.5	93
As	7.4	7.5	7.4	2.0	9.9	125
Be	0.17	0.21	0.19	10	9.7	95
Cd	2.1	1.9	2.0	10	12	100
Cr	15	16	16	100	108	92
Cu	4.4	4.6	4.5	100	102	98
Hg	<.05	<.05	<.05	.10	.1	100
Ni	4.8	4.7	4.8	100	97	92
Pb	58	59	58	50	110	104
Sb	1.3	1.0	1.2	2.0	3.0	90
Se	<.3	<.30	<.30	2.0	2.0	100
Tl	<.2	<.20	<.20	2.0	1.5	75
Zn	44	47	46	100	140	94
CN	<.2	<.2	<.2	.30	.29	97

TABLE 3. WAVELENGTHS FOR ELEMENTS USED WITH ATOMIC ABSORPTION ANALYSIS

Elem.	A.A.	F.E.	Elem.	A.A.	F.E.	Elem.	A.A.	F.E.
Ag	3280.7	3280.7	Hg	2536.5	2536.5	Rh	3434.9	3692.4
Al	3092.7	3961.5	Ho	4103.8	4053.9	Ru	3498.9	3728.0
As	1937.0	2349.8	In	3039.4	4511.3	Sb	2175.9	2598.0
Au	2428.0	2676.0	Ir	2639.7	3800.1	Sc	3911.8	4020.4
B	2497.7	2496.8	K	7664.9	7664.9	Se	1960.3	
Ba	5535.5	5535.5	La	5501.3	5791.3	Si	2516.1	2516.1
Be	2348.6	2348.6	LaO		4418.2	Sm	4296.7	4760.3
BeO		4708.6	Li	6707.8	6707.8	Sn	2246.0	2840.0
Bi	2230.6	2230.6	Lu	3312.1	4518.6	Sr	4607.3	4607.3
Ca	4226.7	4226.7	Mg	2852.1	2852.1	Ta	2714.7	4812.8
Cd	2288.0	3261.1	Mn	2794.8	4030.8	Tb	4326.5	4318.8
Ce		5697.0	Mo	3132.6	3903.0	Te	2142.7	2383.2
Co	2407.2	3453.5	Na	5890.0	5890.0	Th		5760.6
Cr	3578.7	4254.4	Nb	3343.7	4058.9	Ti	3642.7	3998.6
Cs	8521.1	8521.1	Nd	4634.2	4924.5	Tl	2767.9	5350.5
Cu	3247.5	3274.0	Ni	2320.0	3414.8	Tm	3717.9	3717.9
Dy	4211.7	4046.0	Os	2909.0	4420.5	U	3514.6	5915.4
Er	4008.0	4008.0	P	2136.2		V	3184.0	4379.2
Eu	4594.0	4594.0	Pb	2833.1	4057.8	W	4008.8	4008.8
Fe	2483.3	3719.9	Pd	2476.4	3634.7	Y	4077.4	3620.9
Ga	2874.2	4033.0	Pr	4951.4	4951.4	Yb	3988.0	3988.0
Gd	3684.1	4401.9	Pt	2659.5	2659.5	Zn	2138.6	2138.6
Ge	2651.2	2651.2	Rb	7800.2	7800.2	Zr	3601.2	3601.2
Hf	3072.9	3682.2	Re	3460.5	3460.5			

TABLE 4. WAVELENGTHS FOR ELEMENTS USED WITH ICAP ANALYSIS

% Mo.	Element	Channel	Slit Width	Wave Length
1	Tl	0	50	190.86
2	As	1	50	193.76
3	Se	2	50	196.03
4	Cr	3	50	205.55
5	Sb	4	50	206.89
6	B	5	50	208.96
7	Zn	6	50	213.86
8	Pb	7	50	220.35
9	Cd	8	50	226.50
10	Ni	9	50	231.60
11	Ba	10	50	233.53
12	Co	11	50	237.86
13	Mn	12	50	257.61
14	Fe	13	50	259.94
15	Mo	14	50	279.55
16	Al	15	50	308.22
17	V	16	50	311.07
18	Be	12	50	313.04
19	Ca	13	50	317.93
20	Cu	19	50	324.75
21	Ag	20	50	328.07
22	Ti	21	50	337.28
23	Na	22	50	589.59
24	K	23	50	766.50
Ref.	C	JY 38	40/40	293.03

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APPENDIX U

DETAILED COST ESTIMATE FOR TD/UV PHOTOLYSIS TREATMENT OF DIOXIN-CONTAMINATED SOIL

Exhibit 1. 20,000 Tons

Exhibit 2. 40,000 Tons

Exhibit 3. 10,000 Tons

The documents contained in this appendix were published according to their own internal style, which deviates from ESL format. They have, therefore, been published without editing.

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APPENDIX U, EXHIBIT 1. DETAILED COST ESTIMATE FOR TD/UV PHOTOLYSIS TREATMENT OF 20,000 TONS OF SOIL AT NCBC

Item	Quantity	Units	Unit Price	Cost ($1000)	Comments
CATEGORY 1: COMMON REMEDIAL COSTS					
MOBILIZATION					
General mobilization and demobilization	1	ls	82,000	82	5% of Category 1 subtotal cost
Community relations	1	ls	40,000	40	Region IV hearings
Engineering support	1	ls	15,000	15	Develop site and reports
CONSTRUCTION					
Ancillary buildings and equipment:					
a) Water treatment facility	1	ls	300,000	300	GAC facility, 25 gpm (50 gpm peak) for decon, runoff, quench
b) Office trailer	8	mo	380	3	50 ft x 10 ft trailer
c) Employee trailer - breakroom	8	mo	380	3	50 ft x 10 ft trailer
d) Forklift for material preparation	5	mo	1,581	8	--
Utility upgrade:					
a) Electrical services construction	1	ls	68,000	68	$58,000 for main facility, $10,000 for excavation site area
b) Outdoor lights	5	ea	1,400	7	--
c) Water supply allowance	1	ls	20,000	20	--
d) Sewer connection	1	ls	30,000	30	--
e) Natural gas line	1	ls	30,000	30	Fuel to heat soil desorber
f) Telephone service allowance	1	ls	10,000	10	--
Excavation site buildings:					
a) Decontamination trailer rental (2)	8	mo	2,000	16	Trailer each for excavation crew and TD/UV crew
b) Vehicle decontamination station	1	ls	30,000	30	--
EXCAVATION, LOAD, AND HAUL					
Equipment:					
a) Dump trucks (2)	5	mo	10,100	51	10 cy capacity
b) Front end loader	5	mo	12,000	60	4 cy capacity, used to excavate

APPENDIX U, EXHIBIT 1. DETAILED COST ESTIMATE FOR TD/UV PHOTOLYSIS TREATMENT OF 20,000 TONS OF SOIL AT NCBC (CONTINUED)

Item	Quantity	Units	Unit Price	Cost ($1000)	Comments
c) Front end loader	5	mo	6,000	30	2 cy capacity, used in stock pile area to load soil preparation facility and feed hopper
d) Crawler tractor with blade	5	mo	3,200	16	Use intermittently to break up soil in field; also for final grading during restoration; assume operated by a truck driver or front end loader operator
e) Water truck	5	mo	3,000	15	Dust control
Material:					
a) Storage bin wood timbers and steel plate	1	ls	32,000	32	Use to build 11 soil storage bins, 4 for feedstock and 7 for treated soil in quarantine
b) Protective equipment --Level C (7 sets/dy)	126	dy	443	56	Purchase and disposal of protective equipment, change each day
--Level D (7 sets/dy)	126	dy	187	24	Purchase and disposal of protective equipment for truck drivers; change each day
SITE RESTORATION					
Equipment:					
a) Roll-off truck	5	mo	1,984	10	Use to move roll-off boxes TD unit to treated soil storage quarantine area
b) Dump truck	5	mo	5,050	25	10 cy capacity, used to take released clean soil to clean excavations
c) Front end loader	5	mo	12,000	60	4 cy capacity, used to load dump truck at treated soil storage area
Material:					
a) Roll-off boxes	5	ea	5,000	25	15 ton capacity, collect treated soil from TD unit
b) Salvage	5	ea	2,500	-12	Salvage roll-off boxes after decontamination
Top soil replacement	1,880	cy	13.5	25	10% of 18,800 cy
Erosion matting & reseeding	84,700	sy	2.2	186	--

APPENDIX U, EXHIBIT 1. DETAILED COST ESTIMATE FOR TD/UV PHOTOLYSIS TREATMENT OF 20,000 TONS OF SOIL AT NCBC (CONTINUED)

Item	Quantity	Units	Unit Price	Cost ($1000)	Comments
PERSONNEL					
Labor (Construction/Operators):					
a) Construction/assembly (18)	4.5	wk	18,000	81	Set up Category 1 and 2 facilities, utilities, and build soil storage bins; labor rates $25/hr
b) Bin construction (3)	4	wk	3,000	12	Complete soil storage bin construction; labor rate $25/hr
c) Trial burn (3)	4	wk	3,000	12	Excavation crew; labor rate $25/hr
d) Treat soil (11)	14	wk	11,000	154	Excavation/restoration crew; labor rate $25/hr
e) Decon/disassemble (11)	3.5	wk	11,000	39	Use excavation/restoration crew
Labor (Health & Safety):					
a) Setup & trial burn (1)	8.5	wk	1,000	8	Labor rate $25/hr
b) Treat soil (2)	14	wk	2,000	28	--
c) Decon/disassemble (1)	4.5	wk	1,000	5	--
Per diem (H&S personnel)	41	wk	250	10	25% of labor rate
Training	11	ea	1,000	11	Safety training for all; sampling protocols for excavation crew taking samples
Physicals	22	ea	600	13	2 per worker for personnel operating in contaminated area
COMMON REMEDIAL COST SUBTOTAL				1,638	
Contingencies (25%)	--	--	--	409	Factor applied to subtotal
General administration (13%)	--	--	--	266	Factor applied to subtotal and contingencies
Contractor fee (8%)	--	--	--	185	Factor applied to subtotal and contingencies and GA
CATEGORY 1: TOTAL COMMON REMEDIAL COST				2,498	

APPENDIX U, EXHIBIT 1. DETAILED COST ESTIMATE FOR TD/UV PHOTOLYSIS TREATMENT OF 20,000 TONS OF SOIL AT NCBC (CONTINUED)

Item	Quantity	Units	Unit Price	Cost ($1000)	Comments
CATEGORY 2: COMMON OPERATING AND MONITORING COSTS					
COORDINATING					
On-scene coordinator	26	wk	1,000	26	Labor rate $25/hr
Per diem	26	wk	250	7	25% of labor cost
MONITORING AND ANALYSIS PROGRAM					
On-site lab facility	8	mo	24,000	192	Trailer including HRGC/LRMS, GC, and ancillary equipment
Analytical lab operation:					
a) Chemists (5)	17	wk	7,000	119	Rate $35/hr; 1 chemist/shift, 4 shifts and 1 supervisor; use 1 shift of 2 chemists during trial burn period of 4 weeks
b) Per diem	17	wk	1,750	30	25% of labor cost
c) Technicians (4)	14	wk	3,680	52	Rate $23/hr; 1 technician per shift during treat soil period
d) Per diem	14	wk	920	13	25% of labor cost
e) Expendables and misc.	18	wk	2,500	45	--
Area air monitoring stations	4	ea	2,500	10	PS-1 PUF type high volume air particulate monitors
Trial burn sampling and offsite analysis:					
a) Technicians (5)	4	wk	11,000	44	Rate $55/hr; two for process sampling, three for MM5 and VOST sampling
b) Per diem	4	wk	2,750	11	25% of labor cost
c) Gas analysis	1	ls	70,000	70	Fly MM5 and VOST gas samples to laboratory on mainland
FACILITY OPERATIONS					
Water treatment operation:					
a) General	18	wk	130	2	--
b) Carbon replacement	17,000	lb	2.00	34	1 lb carbon/1000 gal; decon, quench, runoff
c) Discharge to POTW	17,000	1000 gal	1.20	20	--
d) Maintenance (misc)	1	ls	20,000	20	10% of facility capital cost

APPENDIX U, EXHIBIT 1. DETAILED COST ESTIMATE FOR TD/UV PHOTOLYSIS TREATMENT OF 20,000 TONS OF SOIL AT NCBC (CONTINUED)

Item	Quantity	Units	Unit Price	Cost ($1000)	Comments
Water user charge	2,400	1000 gal	0.80	2	14 gpm x 60 min/hr x 24 hr/dy x 120 dy; decon and ancil facility
Electricity	421,000	kwh	0.048	20	100 kW normal operation of Category 2 equipment
Labor:					
a) Operators-trial burn (2)	4	wk	2,080	8	Rate $26/hr
b) Operators-trial soil (2)	14	wk	6,240	29	Rate $26/hr
c) Standby (2)	10	wk	2,000	20	Rate $25/hr, look after Category 1 and 2 equipment during period after trial burn before start treating soil
COMMON OPERATING AND MONI. COST SUBTOTAL				774	
Contingencies (20%)	--	--	--	155	Factor applied to subtotal
General Administration (13%)	--	--	--	121	Factor applied to subtotal and contingencies
Contractor fee (8%)	--	--	--	84	Factor applied to subtotal and contingencies and GA
CATEGORY 2: TOTAL COMMON OPERATNG AND MONITORING COSTS				1,134	
CATEGORY 3: TD/UV FACILITY SITE SETUP/REMOVAL COSTS					
PLANNING AND SITE PREPARATION	1	ls	54,000	54	--
LOADING, TRANSPORTATION, AND UNLOADING TO AND FROM SITE	1	ls	132,000	132	12 pieces (Categories 3 & 4), Table 46 is text for detail listing of pieces, volumes, and weights assumed. All pieces from Tulsa, OK, to NCBC and return.
NCBC ACTIVITIES					
Labor:					
a) Off-load & assemble (11)	5.5	wk	13,200	73	Rate $30/hr (average), see Table 47 in text for detail listing

APPENDIX U, EXHIBIT 1. DETAILED COST ESTIMATE FOR TD/UV PHOTOLYSIS TREATMENT OF 20,000 TONS OF SOIL AT NCBC (CONTINUED)

Item	Quantity	Units	Unit Price	Cost ($1000)	Comments
b) Trial burn (10)	4	wk	12,000	48	Rate $30/hr (average), see Table 47 in text for detail listing
c) Standby (2) preparation	10	wk	2,400	24	Rate $30/hr, look after Category 3 and 4 equipment during period after trial burn before start treating soil
d) Decon/disassemble (11)	4.5	wk	13,200	59	Rate $30/hr (average)
e) Per diem	164	wk	300	49	25% of labor cost
Misc. Supplies and Equipment	1	ls	75,000	75	--
FACILITY SITE SETUP/REMOVAL COST SUBTOTAL				514	
Contingencies (25%)	--	--	--	129	Factor applied to subtotal
General administration (13%)	--	--	--	84	Factor applied to subtotal and contingencies
Contractor fee (8%)	--	--	--	58	Factor applied to subtotal and contingencies and GA
CATEGORY 3: TOTAL TD/UV FACILITY SITE SETUP/REMOVAL COSTS				785	
CATEGORY 4: TD/UV FACILITY O&M COSTS					
EQUIPMENT USE CHARGE	9	mo	102,000	918	Initial capital cost $5.5 million, 5-yr life straight line depreciation, 90% utilization factor to determine an equivalent monthly use charge
OPERATION OF TD/UV FACILITY					
Utilities:					
a) Electricity	1.8×10^6	kWh	0.048	86	83 kWh/ton of soil treated; 61 kWh for UV photolysis, 22 kWh for TD, feed prep; includes 10% for trial burn
b) Nitrogen	1.3×10^5	100 ft^3	0.40	53	600 ft^3/ton of soil treated; represents LN_2 delivered by truck plus lease of storage tank and vaporizer; includes 10% for trial burn

APPENDIX U, EXHIBIT 1. DETAILED COST ESTIMATE FOR TD/UV PHOTOLYSIS TREATMENT OF 20,000 TONS OF SOIL AT NCBC (CONTINUED)

Item	Quantity	Units	Unit Price	Cost ($1000)	Comments
c) Water user charge	5,300	1000 gal	0.80	4	240 gal/ton of soil treated; make up water to packaged cooling tower system; includes 10% for trial burn
d) Natural gas	5.3×10^4	10^6Btu	5.00	265	2.4×10^6 Btu/ton of soil treated; includes 10% for trial burn
Maintenance and Materials					
a) Scrubber solvent	7,500	gal	6.00	45	Initial fill 4000 gal; make up for losses 35 gal/day for 100 days
b) Isopropyl alcohol	1,400	gal	2.00	3	Daily makeup for losses in 14 gal, 100 days
c) Activated carbon-emissions control	7×10^4	lb	1.85	130	29 lb/hr carbon consumption rate, 100 days
d) Activated carbon-waste water treatment	1.4×10^4	lb	1.40	20	6 lb/hr carbon consumption rate, 100 days
e) Filter media replacements	1	ls	2,000	2	For emission control and waste water treatment.
f) Equipment maintenance	20,000	tons	3.50	70	Replacement parts at 3% of capital per year charged for 18 weeks plus labor during and following operation other than done by maintenance people assigned to the normal field crew.
g) Level C consumables	2,800	ea	38	106	26 sets protective clothing per day average for 100 days
h) Level C non-consumables	34	ea	131	4	1 set per worker plus 2 spares
i) Miscellaneous supplies	1	ls	20,000	20	--
Labor:					
a) Site superintendent b) Clerk c) Shift supervisors (4) d) Maintenance personnel (2) e) TD/UV operators (8) f) Yard operators (4) g) Soil treatment operators (4) h) Relief operators (4) i) Engineer/safety personnel (2)	14	wk	36,000	504	Consolidated weekly rate based on current (1986) DCAA audited ITC rates for individual specialties and Department of Labor rates for locally hired personnel. Average (composite) labor overhead is 116%. Also includes some offsite parttime work by a project manager, buyer, and secretary.
j) Per diem and general expense	14	mo	9,000	126	25% of total labor cost for 30 employees

APPENDIX U, EXHIBIT 1. DETAILED COST ESTIMATE FOR TD/UV PHOTOLYSIS TREATMENT OF 20,000 TONS OF SOIL AT NCBC (CONCLUDED)

Item	Quantity	Units	Unit Price	Cost ($1000)	Comments
Waste Disposal:					
a) Tar generated by UV photolysis	3,500	gal	10	35	35 gal per day generated, 100 days
b) Spent scrubber solvent inventory at completion	4,000	gal	10	40	Volume of system
c) Protective clothing	300	pac	100	30	3 fiber pacs per day, 100 days
d) Filter media	144	pac	100	7	4 fiber pacs per week, 18 weeks
TD/UV FACILITY O&M COST SUBTOTAL				2,468	
Contingencies (20%)	--	--	--	494	Factor applied to subtotal
General Administration (13%)	--	--	--	385	Factor applied to subtotal on contingencies
Contractor fee (8%)	--	--	--	268	Factor applied to subtotal and contingencies and GA
CATEGORY 4: TOTAL TD/UV FACILITY O&M COSTS				3,615	
TOTAL ESTIMATED COST				8,030	

APPENDIX U, EXHIBIT 2. DETAILED COST ESTIMATE FOR TD/UV PHOTOLYSIS TREATMENT OF 40,000 TONS OF SOIL AT NCBC

Item	Quantity	Units	Unit Price	Cost ($1000)	Comments
CATEGORY 1: COMMON REMEDIAL COSTS					
MOBILIZATION					
General mobilization and demobilization	1	ls	82,000	82	5% of Category 1 subtotal cost
Community relations	1	ls	40,000	40	Region IV hearings
Engineering support	1	ls	15,000	15	Develop site and reports
CONSTRUCTION					
Ancillary buildings and equipment:					
a) Water treatment facility	1	ls	300,000	300	GAC facility, 25 gpm (50 gpm peak) for decon, runoff, quench
b) Office trailer	11	mo	380	4	50 ft x 10 ft trailer
c) Employee trailer - breakroom	11	mo	380	4	50 ft x 10 ft trailer
d) Forklift for material preparation	8	mo	1,581	13	--
Utility upgrade:					
a) Electrical services construction	1	ls	68,000	68	$58,000 for main facility, $10,000 for excavation site area
b) Outdoor lights	5	ea	1,400	7	--
c) Water supply allowance	1	ls	20,000	20	--
d) Sewer connection	1	ls	30,000	30	--
e) Natural gas line	1	ls	30,000	30	Fuel to heat soil desorber
f) Telephone service allowance	1	ls	10,000	10	--
Excavation site buildings:					
a) Decontamination trailer rental (2)	11	mo	2,000	22	Trailer each for excavation crew and TD/UV crew
b) Vehicle decontamination station	1	ls	30,000	30	--
EXCAVATION, LOAD, AND HAUL					
Equipment:					
a) Dump trucks (2)	8	mo	10,100	81	10 cy capacity
b) Front end loader	8	mo	12,000	96	4 cy capacity, used to excavate

APPENDIX U, EXHIBIT 2. DETAILED COST ESTIMATE FOR TD/UV PHOTOLYSIS TREATMENT OF 40,000 TONS OF SOIL AT NCBC (CONTINUED)

Item	Quantity	Units	Unit Price	Cost ($1000)	Comments
c) Front end loader	8	mo	6,000	48	2 cy capacity, used in stock pile area to load soil preparation facility and feed hopper
d) Crawler tractor with blade	8	mo	3,200	26	Use intermittently to break up soil in field; also for final grading during restoration; assume operated by a truck driver or front end loader operator
e) Water truck	8	mo	3,000	24	Dust control
Material:					
a) Storage bin wood timbers and steel plate	1	ls	32,000	32	Use to build 11 soil storage bins, 4 for feedstock and 7 for treated soil in quarantine
b) Protective equipment --Level C (7 sets/dy)	224	dy	443	99	Purchase and disposal of protective equipment, change each day
--Level D (7 sets/dy)	224	dy	187	42	Purchase and disposal of protective equipment for truck drivers; change each day
SITE RESTORATION					
Equipment:					
a) Roll-off truck	8	mo	1,984	16	Use to move roll-off boxes TD unit to treated soil storage quarantine area
b) Dump truck	8	mo	5,050	40	10 cy capacity, used to take released clean soil to clean excavations
c) Front end loader	8	mo	12,000	96	4 cy capacity, used to load dump truck at treated soil storage area
Material:					
a) Roll-off boxes	5	ea	5,000	25	15 ton capacity, collect treated soil from TD unit
b) Salvage	5	ea	2,500	-12	Salvage roll-off boxes after decontamination
Top soil replacement	3,760	cy	13.5	51	10% of 37,600 cy
Erosion matting & reseeding	84,700	sy	2.2	186	--

APPENDIX U, EXHIBIT 2. DETAILED COST ESTIMATE FOR TD/UV PHOTOLYSIS TREATMENT OF 40,000 TONS OF SOIL AT NCBC (CONTINUED)

Item	Quantity	Units	Unit Price	Cost ($1000)	Comments
PERSONNEL					
Labor (Construction/Operators):					
a) Construction/assembly (18)	4.5	wk	18,000	81	Set up Category 1 and 2 facilities, utilities, and build soil storage bins; labor rates $25/hr
b) Bin construction (3)	4	wk	3,000	12	Complete soil storage bin construction; labor rate $25/hr
c) Trial burn (3)	4	wk	3,000	12	Excavation crew; labor rate $25/hr
d) Treat soil (11)	28	wk	11,000	308	Excavation/restoration crew; labor rate $25/hr
e) Decon/disassemble (11)	3.5	wk	11,000	39	Use excavation/restoration crew
Labor (Health & Safety):					
a) Setup & trial burn (1)	8.5	wk	1,000	8	Labor rate $25/hr
b) Treat soil (2)	28	wk	2,000	56	--
c) Decon/disassemble (1)	3.5	wk	1,000	4	--
Per diem (H&S personnel)	41	wk	250	10	25% of labor rate
Training	11	ea	1,000	11	Safety training for all; sampling protocols for excavation crew taking samples
Physicals	22	ea	600	13	2 per worker for personnel operating in contaminated area
COMMON REMEDIAL COST SUBTOTAL				2,077	
Contingencies (25%)	--	--	--	519	Factor applied to subtotal
General administration (13%)	--	--	--	337	Factor applied to subtotal and contingencies
Contractor fee (8%)	--	--	--	235	Factor applied to subtotal and contingencies and GA
CATEGORY 1: TOTAL COMMON REMEDIAL COST				3,168	

APPENDIX U, EXHIBIT 2. DETAILED COST ESTIMATE FOR TD/UV PHOTOLYSIS TREATMENT OF 40,000 TONS OF SOIL AT NCBC (CONTINUED)

Item	Quantity	Units	Unit Price	Cost ($1000)	Comments
CATEGORY 2: COMMON OPERATING AND MONITORING COSTS					
COORDINATING					
On-scene coordinator	41	wk	1,000	41	Labor rate $25/hr
Per diem	41	wk	250	10	25% of labor cost
MONITORING AND ANALYSIS PROGRAM					
On-site lab facility	11	mo	24,000	264	Trailer including HRGC/LRMS, GC, and ancillary equipment
Analytical lab operation:					
a) Chemists (5)	31	wk	7,000	217	Rate $35/hr; 1 chemist/shift, 4 shifts and 1 supervisor; use 1 shift of 2 chemists during trial burn period of 4 weeks
b) Per diem	31	wk	1,750	54	25% of labor cost
c) Technicians (4)	28	wk	3,680	103	Rate $23/hr; 1 technician per shift during treat soil period
d) Per diem	28	wk	920	26	25% of labor cost
e) Expendables and misc.	32	wk	2,500	80	--
Area air monitoring stations	4	ea	2,500	10	PS-1 PUF type high volume air particulate monitors
Trial burn sampling and offsite analysis:					
a) Technicians (5)	4	wk	11,000	44	Rate $55/hr; two for process sampling, three for MM5 and VOST sampling
b) Per diem	4	wk	2,750	11	25% of labor cost
c) Gas analysis	1	ls	70,000	70	Fly MM5 and VOST gas samples to laboratory on mainland
FACILITY OPERATIONS					
Water treatment operation:					
a) General	32	wk	130	4	--
b) Carbon replacement	17,000	lb	2.00	34	1 lb carbon/1000 gal; decon, quench, runoff
c) Discharge to POTW	17,000	1000 gal	1.20	20	--
d) Maintenance (misc)	1	ls	30,000	30	10% of facility capital cost

APPENDIX U, EXHIBIT 2. DETAILED COST ESTIMATE FOR TD/UV PHOTOLYSIS TREATMENT OF 40,000 TONS OF SOIL AT NCBC (CONTINUED)

Item	Quantity	Units	Unit Price	Cost ($1000)	Comments
Water user charge	2,400	1000 gal	0.80	2	14 gpm x 60 min/hr x 24 hr/dy x 120 dy; decon and ancil facility
Electricity	804,000	kwh	0.048	39	100 kW normal operation of Category 2 equipment
Labor:					
a) Operators-trial burn (2)	4	wk	2,080	8	Rate $26/hr
b) Operators-trial soil (2)	28	wk	6,240	58	Rate $26/hr
c) Standby (2)	10	wk	2,000	20	Rate $25/hr, look after Category 1 and 2 equipment during period after trial burn before start treating soil
COMMON OPERATING AND MONITORING COST SUBTOTAL				1,146	
Contingencies (20%)	--	--	--	229	Factor applied to subtotal
General Administration (13%)	--	--	--	179	Factor applied to subtotal and contingencies
Contractor fee (8%)	--	--	--	124	Factor applied to subtotal and contingencies and GA
CATEGORY 2: TOTAL COMMON OPERATNG AND MONITORING COSTS				1,678	
CATEGORY 3: TD/UV FACILITY SITE SETUP/REMOVAL COSTS					
PLANNING AND SITE PREPARATION	1	ls	54,000	54	--
LOADING, TRANSPORTATION, AND UNLOADING TO AND FROM SITE	1	ls	132,000	132	12 pieces (Categories 3 & 4), Table 46 is text for detail listing of pieces, volumes, and weights assumed. All pieces from Tulsa, OK, to NCBC and return.
NCBC ACTIVITIES					
Labor:					
a) Off-load & assemble (11)	5.5	wk	13,200	73	Rate $30/hr (average), see Table 47 in text for detail listing

APPENDIX U, EXHIBIT 2. DETAILED COST ESTIMATE FOR TD/UV PHOTOLYSIS TREATMENT OF 40,000 TONS OF SOIL AT NCBC (CONTINUED)

Item	Quantity	Units	Unit Price	Cost ($1000)	Comments
b) Trial burn (10)	4	wk	12,000	48	Rate $30/hr (average), see Table 47 in text for detail listing
c) Standby (2) preparation	10	wk	2,400	24	Rate $30/hr, look after Category 3 and 4 equipment during period after trial burn before start treating soil
d) Decon/disassemble (11)	4.5	wk	13,200	59	Rate $30/hr (average)
e) Per diem	164	wk	300	49	25% of labor cost
Misc. Supplies and Equipment	1	ls	75,000	75	--
FACILITY SITE SETUP/REMOVAL COST SUBTOTAL				514	
Contingencies (25%)	--	--	--	129	Factor applied to subtotal
General administration (13%)	--	--	--	84	Factor applied to subtotal and contingencies
Contractor fee (8%)	--	--	--	58	Factor applied to subtotal and contingencies and GA
CATEGORY 3: TOTAL TD/UV FACILITY SITE SETUP/REMOVAL COSTS				785	
CATEGORY 4: TD/UV FACILITY O&M COSTS					
EQUIPMENT USE CHARGE	12	mo	102,000	1,224	Initial capital cost $5.5 million, 5-yr life straight line depreciation, 90% utilization factor to determine an equivalent monthly use charge
OPERATION OF TD/UV FACILITY					
Utilities:					
a) Electricity	3.5×10^6	kWh	0.048	168	83 kWh/ton of soil treated; 61 kWh for UV photolysis, 22 kWh for TD, feed prep; includes 10% for trial burn
b) Nitrogen	2.5×10^5	100 ft^3	0.40	101	600 ft^3/ton of soil treated; represents LN_2 delivered by truck plus lease of storage tank and vaporizer; includes 10% for trial burn

APPENDIX U, EXHIBIT 2. DETAILED COST ESTIMATE FOR TD/UV PHOTOLYSIS TREATMENT OF 40,000 TONS OF SOIL AT NCBC (CONTINUED)

Item	Quantity	Units	Unit Price	Cost ($1000)	Comments
c) Water user charge	10,000	1000 gal	0.80	8	240 gal/ton of soil treated; make up water to packaged cooling tower system; includes 10% for trial burn
d) Natural gas	1.0×10^5	10^6Btu	5.00	505	2.4×10^6 Btu/ton of soil treated; includes 10% for trial burn
Maintenance and Materials					
a) Scrubber solvent	11,000	gal	6.00	66	Initial fill 4000 gal; make up for losses 35 gal/day for 100 days
b) Isopropyl alcohol	2,800	gal	2.00	6	Daily makeup for losses in 14 gal, 100 days
c) Activated carbon-emissions control	1.4×10^5	lb	1.85	259	29 lb/hr carbon consumption rate, 100 days
d) Activated carbon-waste water treatment	2.8×10^4	lb	1.40	39	6 lb/hr carbon consumption rate, 100 days
e) Filter media replacements	1	ls	2,000	2	For emission control and waste water treatment.
f) Equipment maintenance	40,000	tons	3.50	140	Replacement parts at 3% of capital per year charged for 18 weeks plus labor during and following operation other than done by maintenance people assigned to the normal field crew.
g) Level C consumables	5,600	ea	38	213	26 sets protective clothing per day average for 100 days
h) Level C non-consumables	34	ea	131	4	1 set per worker plus 2 spares
i) Miscellaneous supplies	1	ls	20,000	30	--
Labor:					
a) Site superintendent b) Clerk c) Shift supervisors (4) d) Maintenance personnel (2) e) TD/UV operators (8) f) Yard operators (4) g) Soil treatment operators (4) h) Relief operators (4) i) Engineer/safety personnel (2)	28	wk	36,000	1,008	Consolidated weekly rate based on current (1986) DCAA audited ITC rates for individual specialties and Department of Labor rates for locally hired personnel. Average (composite) labor overhead is 116%. Also includes some offsite parttime work by a project manager, buyer, and secretary.
j) Per diem and general expense	28	mo	9,000	252	25% of total labor cost for 30 employees

APPENDIX U, EXHIBIT 2. DETAILED COST ESTIMATE FOR TD/UV PHOTOLYSIS TREATMENT OF 40,000 TONS OF SOIL AT NCBC (CONCLUDED)

Item	Quantity	Units	Unit Price	Cost ($1000)	Comments
Waste Disposal:					
a) Tar generated by UV photolysis	7,500	gal	10	70	35 gal per day generated, 100 days
b) Spent scrubber solvent inventory at completion	4,000	gal	10	40	Volume of system
c) Protective clothing	300	pac	100	60	3 fiber pacs per day, 100 days
d) Filter media	144	pac	100	14	4 fiber pacs per week, 18 weeks
TD/UV FACILITY O&M COST SUBTOTAL				4,209	
Contingencies (20%)	--	--	--	842	Factor applied to subtotal
General Administration (13%)	--	--	--	657	Factor applied to subtotal on contingencies
Contractor fee (8%)	--	--	--	457	Factor applied to subtotal and contingencies and GA
CATEGORY 4: TOTAL TD/UV FACILITY O&M COSTS				6,165	
TOTAL ESTIMATED COST				11,796	

APPENDIX U, EXHIBIT 3. DETAILED COST ESTIMATE FOR TD/UV PHOTOLYSIS TREATMENT OF 10,000 TONS OF SOIL AT NCBC

Item	Quantity	Units	Unit Price	Cost ($1000)	Comments
CATEGORY 1: COMMON REMEDIAL COSTS					
MOBILIZATION					
General mobilization and demobilization	1	ls	82,000	82	5% of Category 1 subtotal cost
Community relations	1	ls	40,000	40	Region IV hearings
Engineering support	1	ls	15,000	15	Develop site and reports
CONSTRUCTION					
Ancillary buildings and equipment:					
a) Water treatment facility	1	ls	300,000	300	GAC facility, 25 gpm (50 gpm peak) for decon, runoff, quench
b) Office trailer	6	mo	380	2	50 ft x 10 ft trailer
c) Employee trailer - breakroom	6	mo	380	2	50 ft x 10 ft trailer
d) Forklift for material preparation	3	mo	1,581	5	--
Utility upgrade:					
a) Electrical services construction	1	ls	68,000	68	$58,000 for main facility, $10,000 for excavation site area
b) Outdoor lights	5	ea	1,400	7	--
c) Water supply allowance	1	ls	20,000	20	--
d) Sewer connection	1	ls	30,000	30	--
e) Natural gas line	1	ls	30,000	30	Fuel to heat soil desorber
f) Telephone service allowance	1	ls	10,000	10	--
Excavation site buildings:					
a) Decontamination trailer rental (2)	6	mo	2,000	12	Trailer each for excavation crew and TD/UV crew
b) Vehicle decontamination station	1	ls	30,000	30	--
EXCAVATION, LOAD, AND HAUL					
Equipment:					
a) Dump trucks (2)	3	mo	10,100	30	10 cy capacity
b) Front end loader	3	mo	12,000	36	4 cy capacity, used to excavate

APPENDIX U, EXHIBIT 3. DETAILED COST ESTIMATE FOR TD/UV PHOTOLYSIS TREATMENT OF 10,000 TONS OF SOIL AT NCBC (CONTINUED)

Item	Quantity	Units	Unit Price	Cost ($1000)	Comments
c) Front end loader	3	mo	6,000	18	2 cy capacity, used in stock pile area to load soil preparation facility and feed hopper
d) Crawler tractor with blade	3	mo	3,200	10	Use intermittently to break up soil in field; also for final grading during restoration; assume operated by a truck driver or front end loader operator
e) Water truck	3	mo	3,000	9	Dust control
Material:					
a) Storage bin wood timbers and steel plate	1	ls	32,000	32	Use to build 11 soil storage bins, 4 for feedstock and 7 for treated soil in quarantine
b) Protective equipment --Level C (7 sets/dy)	73	dy	443	32	Purchase and disposal of protective equipment, change each day
--Level D (7 sets/dy)	73	dy	187	14	Purchase and disposal of protective equipment for truck drivers; change each day
SITE RESTORATION					
Equipment:					
a) Roll-off truck	3	mo	1,984	6	Use to move roll-off boxes TD unit to treated soil storage quarantine area
b) Dump truck	3	mo	5,050	15	10 cy capacity, used to take released clean soil to clean excavations
c) Front end loader	3	mo	12,000	36	4 cy capacity, used to load dump truck at treated soil storage area
Material:					
a) Roll-off boxes	5	ea	5,000	25	15 ton capacity, collect treated soil from TD unit
b) Salvage	5	ea	2,500	-12	Salvage roll-off boxes after decontamination
Top soil replacement	940	cy	13.5	13	10% of 9,400 cy
Erosion matting & reseeding	84,700	sy	2.2	186	--

APPENDIX U, EXHIBIT 3. DETAILED COST ESTIMATE FOR TD/UV PHOTOLYSIS TREATMENT OF 10,000 TONS OF SOIL AT NCBC (CONTINUED)

Item	Quantity	Units	Unit Price	Cost ($1000)	Comments
PERSONNEL					
Labor (Construction/Operators):					
a) Construction/assembly (18)	4.5	wk	18,000	81	Set up Category 1 and 2 facilities, utilities, and build soil storage bins; labor rates $25/hr
b) Bin construction (3)	4	wk	3,000	12	Complete soil storage bin construction; labor rate $25/hr
c) Trial burn (3)	4	wk	3,000	12	Excavation crew; labor rate $25/hr
d) Treat soil (11)	7	wk	11,000	77	Excavation/restoration crew; labor rate $25/hr
e) Decon/disassemble (11)	3.5	wk	11,000	39	Use excavation/restoration crew
Labor (Health & Safety):					
a) Setup & trial burn (1)	8.5	wk	1,000	8	Labor rate $25/hr
b) Treat soil (2)	7	wk	2,000	14	--
c) Decon/disassemble (1)	3.5	wk	1,000	3	--
Per diem (H&S personnel)	25	wk	250	6	25% of labor rate
Training	11	ea	1,000	11	Safety training for all; sampling protocols for excavation crew taking samples
Physicals	22	ea	600	13	2 per worker for personnel operating in contaminated area
COMMON REMEDIAL COST SUBTOTAL				1,379	
Contingencies (25%)	--	--	--	345	Factor applied to subtotal
General administration (13%)	--	--	--	224	Factor applied to subtotal and contingencies
Contractor fee (8%)	--	--	--	156	Factor applied to subtotal and contingencies and GA
CATEGORY 1: TOTAL COMMON REMEDIAL COST				2,104	

APPENDIX U, EXHIBIT 3. DETAILED COST ESTIMATE FOR TD/UV PHOTOLYSIS TREATMENT OF 10,000 TONS OF SOIL AT NCBC (CONTINUED)

Item	Quantity	Units	Unit Price	Cost ($1000)	Comments
CATEGORY 2: COMMON OPERATING AND MONITORING COSTS					
COORDINATING					
On-scene coordinator	19	wk	1,000	19	Labor rate $25/hr
Per diem	19	wk	250	5	25% of labor cost
MONITORING AND ANALYSIS PROGRAM					
On-site lab facility	6	mo	24,000	144	Trailer including HRGC/LRMS, GC, and ancillary equipment
Analytical lab operation:					
a) Chemists (5)	10	wk	7,000	70	Rate $35/hr; 1 chemist/shift, 4 shifts and 1 supervisor; use 1 shift of 2 chemists during trial burn period of 4 weeks
b) Per diem	10	wk	1,750	18	25% of labor cost
c) Technicians (4)	7	wk	3,680	26	Rate $23/hr; 1 technician per shift during treat soil period
d) Per diem	7	wk	920	6	25% of labor cost
e) Expendables and misc.	11	wk	2,500	28	--
Area air monitoring stations	4	ea	2,500	10	PS-1 PUF type high volume air particulate monitors
Trial burn sampling and offsite analysis:					
a) Technicians (5)	4	wk	11,000	44	Rate $55/hr; two for process sampling, three for MM5 and VOST sampling
b) Per diem	4	wk	2,750	11	25% of labor cost
c) Gas analysis	1	ls	70,000	70	Fly MM5 and VOST gas samples to laboratory on mainland
FACILITY OPERATIONS					
Water treatment operation:					
a) General	11	wk	130	1	--
b) Carbon replacement	17,000	lb	2.00	34	1 lb carbon/1000 gal; decon, quench, runoff
c) Discharge to POTW	17,000	1000 gal	1.20	20	--
d) Maintenance (misc)	1	ls	15,000	15	10% of facility capital cost

APPENDIX U, EXHIBIT 3. DETAILED COST ESTIMATE FOR TD/UV PHOTOLYSIS TREATMENT OF 10,000 TONS OF SOIL AT NCBC (CONTINUED)

Item	Quantity	Units	Unit Price	Cost ($1000)	Comments
Water user charge	2,400	1000 gal	0.80	2	14 gpm x 60 min/hr x 24 hr/dy x 120 dy; decon and anci facility
Electricity	230,000	kwh	0.048	11	100 kW normal operation of Category 2 equipment
Labor:					
a) Operators-trial burn (2)	4	wk	2,080	8	Rate $26/hr
b) Operators-trial soil (2)	7	wk	6,240	15	Rate $26/hr
c) Standby (2)	10	wk	2,000	20	Rate $25/hr, look after Category 1 and 2 equipment during period after trial burn before start treating soil
COMMON OPERATING AND MONITORING COST SUBTOTAL				576	
Contingencies (20%)	--	--	--	115	Factor applied to subtotal
General Administration (13%)	--	--	--	90	Factor applied to subtotal and contingencies
Contractor fee (8%)	--	--	--	62	Factor applied to subtotal and contingencies and GA
CATEGORY 2: TOTAL COMMON OPERATNG AND MONITORING COSTS				843	
CATEGORY 3: TD/UV FACILITY SITE SETUP/REMOVAL COSTS					
PLANNING AND SITE PREPARATION	1	ls	54,000	54	--
LOADING, TRANSPORTATION, AND UNLOADING TO AND FROM SITE	1	ls	132,000	132	12 pieces (Categories 3 & 4), Table 46 is text for detail listing of pieces, volumes, and weights assumed. All pieces from Tulsa, OK, to NCBC and return.
NCBC ACTIVITIES					
Labor:					
a) Off-load & assemble (11)	5.5	wk	13,200	73	Rate $30/hr (average), see Table 47 in text for detail listing

APPENDIX U, EXHIBIT 3. DETAILED COST ESTIMATE FOR TD/UV PHOTOLYSIS TREATMENT OF 10,000 TONS OF SOIL AT NCBC (CONTINUED)

Item	Quantity	Units	Unit Price	Cost ($1000)	Comments
b) Trial burn (10)	4	wk	12,000	48	Rate $30/hr (average), see Table 47 in text for detail listing
c) Standby (2) preparation	10	wk	2,400	24	Rate $30/hr, look after Category 3 and 4 equipment during period after trial burn before start treating soil
d) Decon/disassemble (11)	4.5	wk	13,200	59	Rate $30/hr (average)
e) Per diem	164	wk	300	49	25% of labor cost
Misc. Supplies and Equipment	1	ls	75,000	75	--
FACILITY SITE SETUP/REMOVAL COST SUBTOTAL				514	
Contingencies (25%)	--	--	--	129	Factor applied to subtotal
General administration (13%)	--	--	--	84	Factor applied to subtotal and contingencies
Contractor fee (8%)	--	--	--	58	Factor applied to subtotal and contingencies and GA
CATEGORY 3: TOTAL TD/UV FACILITY SITE SETUP/REMOVAL COSTS				785	
CATEGORY 4: TD/UV FACILITY O&M COSTS					
EQUIPMENT USE CHARGE	7	mo	102,000	714	Initial capital cost $5.5 million, 5-yr life straight line depreciation, 90% utilization factor to determine an equivalent monthly use charge
OPERATION OF TD/UV FACILITY					
Utilities:					
a) Electricity	9.8×10^5	kWh	0.048	47	83 kWh/ton of soil treated; 61 kWh for UV photolysis, 22 kWh for TD, feed prep; includes 10% for trial burn
b) Nitrogen	7.2×10^4	100 ft^3	0.40	29	600 ft^3/ton of soil treated; represents LN_2 delivered by truck plus lease of storage tank and vaporizer; includes 10% for trial burn

APPENDIX U, EXHIBIT 3. DETAILED COST ESTIMATE FOR TD/UV PHOTOLYSIS TREATMENT OF 10,000 TONS OF SOIL AT NCBC (CONTINUED)

Item	Quantity	Units	Unit Price	Cost ($1000)	Comments
c) Water user charge	2,900	1000 gal	0.80	2	240 gal/ton of soil treated; make up water to packaged cooling tower system; includes 10% for trial burn
d) Natural gas	2.9×10^4	10^6Btu	5.00	145	2.4×10^6 Btu/ton of soil treated; includes 10% for trial burn
Maintenance and Materials					
a) Scrubber solvent	5,800	gal	6.00	35	Initial fill 4000 gal; make up for losses 35 gal/day for 100 days
b) Isopropyl alcohol	700	gal	2.00	1	Daily makeup for losses in 14 gal, 100 days
c) Activated carbon-emissions control	3.5×10^4	lb	1.85	65	29 lb/hr carbon consumption rate, 100 days
d) Activated carbon-waste water treatment	7,000	lb	1.40	10	6 lb/hr carbon consumption rate, 100 days
e) Filter media replacements	1	ls	2,000	2	For emission control and waste water treatment.
f) Equipment maintenance	10,000	tons	3.50	35	Replacement parts at 3% of capital per year charged for 9 weeks plus labor during and following operation other than done by maintenance people assigned to the normal field crew.
g) Level C consumables	1,400	ea	38	53	26 sets protective clothing per day average for 100 days
h) Level C non-consumables	34	ea	131	4	1 set per worker plus 2 spares
i) Miscellaneous supplies	1	ls	15,000	15	--
Labor:					
a) Site superintendent b) Clerk c) Shift supervisors (4) d) Maintenance personnel (2) e) Truck operators (8) f) Yard operators (4) g) Soil treatment operators (4) h) Relief operators (4) i) Engineer/safety personnel (2)	7	wk	36,000	252	Consolidated weekly rate based on current (1986) DCAA audited ITC rates for individual specialties and Department of Labor rates for locally hired personnel. Average (composite) labor overhead is 116%. Also includes some offsite parttime work by a project manager, buyer, and secretary.
j) Supervision and general expense	7	mo	9,000	63	25% of total labor cost for 30 employees

APPENDIX U, EXHIBIT 3. DETAILED COST ESTIMATE FOR TD/UV PHOTOLYSIS TREATMENT OF 10,000 TONS OF SOIL AT NCBC (CONCLUDED)

Item	Quantity	Units	Unit Price	Cost ($1000)	Comments
Waste Disposal:					
a) Tar generated by UV photolysis	1,800	gal	10	18	35 gal per day generated, 100 days
b) Spent scrubber solvent inventory at completion	4,000	gal	10	40	Volume of system
c) Protective clothing	150	pac	100	15	3 fiber pacs per day, 100 days
d) Filter media	36	pac	100	4	4 fiber pacs per week, 18 weeks
TD/UV FACILITY O&M COST SUBTOTAL				1,550	
Contingencies (20%)	--	--	--	310	Factor applied to subtotal
General Administration (13%)	--	--	--	242	Factor applied to subtotal on contingencies
Contractor fee (8%)	--	--	--	168	Factor applied to subtotal and contingencies and GA
CATEGORY 4: TOTAL TD/UV FACILITY O&M COSTS				2,270	
TOTAL ESTIMATED COST				6,002	

APPENDIX V

ANALYSIS BACKUP

FOR

COST ESTIMATE

The documents contained in this appendix were published according to their own internal style, which deviates from ESL format. They have, therefore, been published without editing.

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EG&G Idaho

INTEROFFICE CORRESPONDENCE

Date: July 21, 1987

To: R. W. Thomas

From: H. J. Welland HJW.

Subject: COST ESTIMATE FOR CLEANUP OF TOXIC WASTE AT GULFPORT, MISSISSIPPI USING THE IT CORP TD/UV PROCESS - REV 1 - HJW-31-87

The attached detailed backup sheets and sensitivity tables describe the estimated costs for cleanup of the Herbicide Orange contaminated site at Gulfport, Mississippi. This estimate was prepared to incorporate comments received form the Air Force on a similar task at Johnston Island in the Pacific Ocean. All previous estimates for the IT Corporations TD/UV process at the NCBC site in Gulfport should be disregarded.

A list of the important assumptions is also attached for your information.

hjw

Attachments:
As Stated

cc: Central Files
Project File 8067-A KLS/RRW
J. N. Casanova
R. L. Billau
H. J. Welland Letter File

"Providing research and development services to the government"

IMPORTANT ASSUMPTIONS

1.0 Assumed Site Conditions:

a. Contaminated area is approximately 18 acres.

b. Contaminated soil is about 8 inches deep.

c. Soil is sand to sandy-loam; however, the soil has been cement stabilized

d. The soil will support the process equipment and truck traffic without concrete foundations and/or graded and prepared roads.

e. The process equipment will be located in a clean area adjacent to the contaminated area.

2.0 Assumed Operating sequence for 20,000 ton base case:

a.	Transport process equipment to site and lease support equipment	1 week
b.	Setup and check out process equipment and setup support equipment	3.5 weeks
c.	Trial Burn	4.0 weeks
d.	Standby	10.0 weeks
e.	Treat Soil	14.0 weeks
f.	Decon and Disassemble Equipment	2.5 weeks
g.	Transport process equipment back to Tulsa and return leased equipment	1.0 week
h.	Refurbish process equipment	3.0 weeks
	Total	39.0 weeks

39 - 3 = 36 weeks = 8.31 months -- use 8 months for process

i. The process crew works 3 shifts per day, 7 days per week; the excavation crew works 1 shift per day, 5 days per week. If the excavation crew falls behind, overtime can be scheduled. No overtime was assumed for this estimate.

IMPORTANT ASSUMPTIONS (CONT)

3.0 Excavation:

a. A crawler tractor with a ripper blade attachment will be used to break up the soil.

b. Two ten cubic yard dump trucks and one four cubic yard front end loader will be used to load and transport the contaminated soil to the process area.

c. The contaminated soil will be stored in covered storage bins. These bins will be fabricated on site.

d. The treated soil will be moved from the treatment equipment to a quarantine area in a 15 cubic yard covered rolloff box.

e. The treated soil will be stored in covered storage bins (similar to c. above) until authorization to release the soil is received. The soil will be kept segregated as much as possible to minimize any reprocessing requirements if higher than acceptable concentrations are found in a batch of treated soil.

f. The delisted soil will be returned to the excavation area using a ten cubic yard dump truck and a four cubic yard frontend loader.

g. Approximately 10 % of the soil will be lost in the process. Soil will be purchased to replace the lost soil.

h. A subcontractor will be brought on site after the soil treatment is complete to make up the 10 % lost soil and to grade and reseed the excavated area.

IMPORTANT ASSUMPTIONS (CONT)

4.0 Personnel:

a. Category 1

Dump Truck Driver	3
Frontend Loader Operator	3
Forklift Operator	1
Crawler Tractor Operator	1
Water Truck Driver	1
Rolloff Truck Driver	1
Excavation foreman	1
Health and Safety	2
Total	13

b. Category 2

Chemists (1 supervisor)	5
Sampling Technicians	4
On-Scene Coordinator	1
Facility Operator (Water Treatment)	2
Total	12

E&G Idaho, Inc.

PROJECT TD/UV DIOXIN CLEANUP---UPGRADE

LOCATION NCBC SITE AT GULFPORT, MISS.

REQUESTER R. W. THOMAS FILE NO. 8067-B

TYPE OF EST. CONCEPTUAL

SOURCE (E) Eng. Est.
(V) Vendor
(P) Pur. Order
(H) Handbook Ref.

Date JULY 2, 1987

Page 1 of 8

Prep. By: H. J. WELLAND

Appr'd By:

ACCT. NO.	DESCRIPTION	E,V, P,H	MAT'L UNIT	MAT'L UT. COST	UNIT LAB. HRS	TOTAL LAB. HRS	LABOR RATE	LABOR COST	MAT'L COST	OTHER COST	TOTAL COST
	CATEGORY 1 COMMON REMEDIAL COSTS					0		0	0		0.0
	GEN MOB AND DEMOB		1 LS	82000		0		0	82,000		82,000.0
	ENGR (DEVELOP SITE & REPORTS)		1 LS	15000		0		0	15,000		15,000.0
	COMMUNITY RELATIONS SUPPORT		1 LS	40000		0		0	40,000		40,000.0
	CONSTRUCTION					0		0	0		0.0
	WATER TREATMENT FACILITY		1 LS	300000		0		0	300,000		300,000.0
	OFFICE TRAILER 10 X 50 FT		8 MO	380		0		0	3,040		3,040.0
	EMPLOYEE TRAILER (BREAKROOM)		8 MO	380		0		0	3,040		3,040.0
	FORKLIFT FOR MATL PREP		5 MO	1581		0		0	7,905		7,905.0
	UTILITY UPGRADE					0		0	0		0.0
	ELECTRICAL SERVICES CONSTRUCTION		1 LS	68000		0		0	68,000		68,000.0
	OUTDOOR LIGHTS		5 EA	1400		0		0	7,000		7,000.0
	WATER SUPPLY ALLOWANCE		1 LS	20000		0		0	20,000		20,000.0
	SEWER CONNECTION		1 LS	30000		0		0	30,000		30,000.0
	TELEPHONE SERVICE ALLOWANCE		1 LS	10000		0		0	10,000		10,000.0
	NATURAL GAS LINE		1 LS	30000		0		0	30,000		30,000.0
	VEHICLE DECON STATION		1 LS	30000		0		0	30,000		30,000.0
	DECON TRAILERS (2)		8 MO	2000		0		0	16,000		16,000.0
						0		0	0		0.0
	EXCAVATION - LOAD & HAUL					0		0	0		0.0
	10 CY DUMP TRUCK (2)		5 MO	10100		0		0	50,500		50,500.0
	TOTAL					0			712485		712,000.0

E&E Idaho, Inc.

PROJECT _____ TYPE OF EST. _____ Date _____

LOCATION _____ SOURCE (E) Eng. Est. (V) Vendor (P) Pur. Order (H) Handbook Ref. Page 2 of 8

REQUESTER _____ Prep. By: _____

Appr'd By: _____

ACCT. NO.	DESCRIPTION	E,V,P,H	MAT'L UNIT	MAT'L UT. COST	UNIT LAB. HRS	TOTAL LAB. HR	LABOR RATE	LABOR COST	MAT'L COST	OTHER COST	TOTAL COST
	4 CY FRONTEND LOADER		5 MO	12000		0		0	60,000		60,000.0
	2 CY FRONTEND LOADER		5 MO	6000		0		0	30,000		30,000.0
	ROLLOFF TRUCK		5 MO	1984		0		0	9,920		9,920.0
	SOIL STORAGE BIN MATERIAL (11)		1 LS	32000		0		0	32,000		32,000.0
	ROLLOFF BOXES FOR TREATED SOIL		5 EA	5000		0		0	25,000		25,000.0
	CRAWLER TRACTOR W/BLADE		5 MO	3200		0		0	16,000		16,000.0
	WATER TANKER FOR DUST CONTROL		5 MO	3000		0		0	15,000		15,000.0
	SITE RESTORATION					0		0	0		0.0
	10 CY DUMP TRUCK		5 MO	5050		0		0	25,250		25,250.0
	4 CY FRONTEND LOADER		5 MO	12000		0		0	60,000		60,000.0
	TOPSOIL PLACEMENT		1880 CY	13.5		0		0	25,380		25,380.0
	EROSION MATTING & RESEEDING		184700 SY	2.2		0		0	186,340		186,340.0
	PHYSICALS 2 PER WORKER		22 EA	600		0		0	13,200		13,200.0
	TRAINING		11 EA	1000		0		0	11,000		11,000.0
	LEVEL C PROTECTIVE EQUIPMENT (7/DY)		126 DY	443		0		0	55,818		55,818.0
	LEVEL D PROTECTIVE EQUIPMENT (7/DY)		126 DY	187		0		0	23,562		23,562.0
	PERSONNEL					0		0	0		0.0
	CONSTRUCTION PERSONNEL (18)		4.5 WK		720	3240	25	81000	0		81,000.0
	TRIAL BURN (OPER + BIN CONST-6)		4 WK		240	960	25	24000	0		24,000.0
	TREAT SOIL (11)		14 WK		440	6160	25	154000	0		154,000.0
	DECON/DISASSEMBLE (11)		3.5 WK		440	1540	25	38500	0		38,500.0
	TOTAL					11900			588470		886,000.0

EG&G Idaho, Inc.

PROJECT _____ TYPE OF EST. _____ Date _____

LOCATION _____ SOURCE (E) Eng. Est. (V) Vendor (P) Pur. Order (H) Handbook Ref. Page 3 of 8

REQUESTER _____ Prep. By: _____

Appr'd By: _____

ACCT. NO.	DESCRIPTION	E,V, P,H	MAT'L UNIT	MAT'L UT. COST	UNIT LAB. HRS	TOTAL LAB. HR	LABOR RATE	LABOR COST	MAT'L COST	OTHER COST	TOTAL COST
	HEALTH & SAFETY SU &TRL BN (1)		8.5 WK		40	340	25	8500	0		8,500.0
	HEALTH & SAFETY TRT SL (2)		14 WK		80	1120	25	28000	0		28,000.0
	HEALTH & SAFETY DECON/DISASSEMBLE (1)		4.5 WK		40	180	25	4500	0		4,500.0
	PER DIEM FOR H & S (25 % LABOR)		41 WK	250		0		0	10,250		10,250.0
	SALVAGE ROLLOFF BOXES		5 EA	-2500		0		0	(12,500)		(12,500.0)
						0		0	0		0.0
						0		0	0		0.0
						0		0	0		0.0
						0		0	0		0.0
						0		0	0		0.0
	COMMON REMEDIAL COSTS SUBTOTAL					0		0	0		1,637,000.0
	CONTINGENCIES (25 %)					0		0	0		409,000.0
	GENERAL ADMINISTRATION (13 %)					0		0	0		266,000.0
	CONTRACTOR FEE (8 %)					0		0	0		185,000.0
	CATEGORY 1 TOTAL COMMON REMEDIAL COST					0		0	0		2,497,000.0
						0		0	0		0.0
						0		0	0		0.0
						0		0	0		0.0
						0		0	0		0.0
						0		0	0		0.0
						0		0	0		0.0
	TOTAL					1640			-2250		

EG&G Idaho, Inc.

PROJECT _____ TYPE OF EST. _____ Date _____

LOCATION _____ SOURCE (E) Eng. Est. (V) Vendor (P) Pur. Order (H) Handbook Ref. Page 4 of 8

REQUESTER _____ Prep. By: _____

Appr'd By: _____

ACCT. NO.	DESCRIPTION	E,V,P,H	MAT'L UNIT	MAT'L UT. COST	UNIT LAB. HRS	TOTAL LAB. HR	LABOR RATE	LABOR COST	MAT'L COST	OTHER COST	TOTAL COST
	COMMON OPERATING & MONITORING COSTS					0		0	0		0.0
	MONITORING & ANALYSIS PROGRAM					0		0	0		0.0
	LAB FACILITY		8 MO	24000		0		0	192,000		192,000.0
	AREA AIR MONITORING STATIONS		4 EA	2500		0		0	10,000		10,000.0
	EXPENDABLES & MISC		18 MK	2500		0		0	45,000		45,000.0
	ANALYTICAL LAB OPERATION					0		0	0		0.0
	CHEMISTS (5)		17 MK		200	3400	35	119000	0		119,000.0
	TECHNICIANS (4)		14 MK		160	2240	23	51520	0		51,520.0
						0		0	0		0.0
						0		0	0		0.0
	FACILITY OPERATION					0		0	0		0.0
	GENERAL		18 MK	130		0		0	2,340		2,340.0
	CARBON REPLACEMENT		117000 LB	2		0		0	34,000		34,000.0
	MAINTENANCE		1 LS	20000		0		0	20,000		20,000.0
	DISCHARGE TO POTW		117000 KGAL	1.2		0		0	20,400		20,400.0
	FACILITY OPERATOR					0		0	0		0.0
	TRIAL BURN (2)		4 MK		80	320	26	8320	0		8,320.0
	PROCESS (2)		14 MK		80	1120	26	29120	0		29,120.0
						0		0	0		0.0
	STANDBY (2)		10 MK		80	800	25	20000	0		20,000.0
	PER DIEM FOR CHEM & TECH (25 %)		141 MK	303		0		0	42,723		42,723.0
	TOTAL					7880			366463		594,423.0

EG&G Idaho, Inc.

PROJECT _____ TYPE OF EST. _____ Date _____

LOCATION _____ SOURCE (E) Eng. Est. (V) Vendor (P) Pur. Order (H) Handbook Ref. Page 5 of 8

REQUESTER _____ Prep. By: _____

Appr'd By: _____

ACCT. NO.	DESCRIPTION	E,V, P,H	MAT'L UNIT	MAT'L UT. COST	UNIT LAB. HRS	TOTAL LAB. HR	LABOR RATE	LABOR COST	MAT'L COST	OTHER COST	TOTAL COST
	ON SCENE COORDINATOR (1)		26 WK		40	1040	25	26000	0		26,000.0
	PER DIEM (25 % OF LABOR)		26 WK	250		0		0	6,500		6,500.0
						0		0	0		0.0
	WATER USER CHARGE		2400 KGAL	0.8		0		0	1,920		1,920.0
	ELECTRICITY ($.048 PER KWHR)		421 MWHR	48		0		0	20,208		20,208.0
						0		0	0		0.0
						0		0	0		0.0
	CHEMICAL ANALYSIS FOR TRIAL BURN					0		0	0		0.0
	PERSONNEL (5)		4 WK		200	800	55	44000	0		44,000.0
	SAMPLE ANALYSIS		1 LS	70000		0		0	70,000		70,000.0
	PER DIEM FOR SAMPLING PERSONNEL		20 WK	550		0		0	11,000		11,000.0
						0		0	0		0.0
						0		0	0		0.0
						0		0	0		0.0
						0		0	0		0.0
	COMMON O & M COST SUBTOTAL					0		0	0		774,000.0
	CONTINGENCIES (20 %)					0		0	0		155,000.0
	GENERAL ADMINISTRATION (13 %)					0		0	0		121,000.0
	CONTRACTOR FEE (8 %)					0		0	0		84,000.0
	CATEGORY 2 COMMON O & M COSTS					0		0	0		1,134,000.0
						0		0	0		0.0
	TOTAL					1840			109628		

E&G Idaho, Inc.

PROJECT _____ TYPE OF EST. _____ Date _____

LOCATION _____ SOURCE (E) Eng. Est. (V) Vendor (P) Pur. Order (H) Handbook Ref. Page 6 of 8

REQUESTER _____ Prep. By: _____

Appr'd By: _____

ACCT. NO.	DESCRIPTION	E,V,P,H	MAT'L UNIT	MAT'L UT. COST	UNIT LAB. HRS	TOTAL LAB. HR	LABOR RATE	LABOR COST	MAT'L COST	OTHER COST	TOTAL COST
	CATEGORY 3 TD/UV SETUP & REMOVAL					0		0	0		0.0
	PLNG & SITE PREPARATION		1 LS	54000		0		0	54,000		54,000.0
	LOAD & SHIP TO SITE & RETURN		1 LS	132000		0		0	132,000		132,000.0
						0		0	0		0.0
	OFF-LOAD & ASSEMBLE (11)		5.5 WK		440	2420	30	72600	0		72,600.0
	TRIAL BURN (10)		4 WK		400	1600	30	48000	0		48,000.0
	STANDBY (2)		10 WK		80	800	30	24000	0		24,000.0
	DECON AND DISASSEMBLE (11)		4.5 WK		440	1980	30	59400	0		59,400.0
	PER DIEM & GENERAL EXPENSE		164 WK	300		0		0	49,200		49,200.0
	MISCELLANEOUS SUPPLIES & EQUIP		1 LS	75000		0		0	75,000		75,000.0
	CATEGORY 3 SUBTOTAL					0		0	0		514,000.0
	CONTINGENCIES (25 %)					0		0	0		129,000.0
	GENERAL ADMINISTRATION (13 %)					0		0	0		84,000.0
	CONTRACTOR FEE (8 %)					0		0	0		58,000.0
	CATEGORY 3 TD/UV SETUP & TEARDOWN COSTS					0		0	0		785,000.0
						0		0	0		0.0
						0		0	0		0.0
						0		0	0		0.0
						0		0	0		0.0
						0		0	0		0.0
						0		0	0		0.0
	TOTAL					6800			310200		

EG&G Idaho, Inc.

PROJECT _____ TYPE OF EST. _____ Date _____

LOCATION _____ SOURCE (E) Eng. Est. (V) Vendor (P) Pur. Order (H) Handbook Ref. Page 7 of 8

REQUESTER _____ Prep. By: _____

Appr'd By: _____

ACCT. NO.	DESCRIPTION	E,V,P,H	MAT'L UNIT	MAT'L UT. COST	UNIT LAB. HRS	TOTAL LAB. HR	LABOR RATE	LABOR COST	MAT'L COST	OTHER COST	TOTAL COST
	CATEGORY 4 TD/UV O & M COSTS					0		0	0		0.0
	EQUIPMENT USE CHARGE		9 MO	102000		0		0	918,000		918,000.0
	UTILITIES					0		0	0		0.0
	ELECTRICITY		1800 MWHR	48		0		0	86,400		86,400.0
	NITROGEN		13200 KCF	4		0		0	52,800		52,800.0
	WATER USER CHARGE		5300 KGAL	0.8		0		0	4,240		4,240.0
	NATURAL GAS		53000 MBTU	5		0		0	265,000		265,000.0
	MAINTENANCE & MATERIALS					0		0	0		0.0
	SCRUBBER SOLVENT		7500 GAL	6		0		0	45,000		45,000.0
	ISOPROPYL ALCOHOL		1400 GAL	2		0		0	2,800		2,800.0
	ACTIVATED CARBON-EMMISSIONS CNTRL		70000 LB	1.85		0		0	129,500		129,500.0
	ACTIVATED CARBON-WASTE WATER TRTMT		14000 LB	1.4		0		0	19,600		19,600.0
	FILTER MEDIA REPLACEMENTS		1 LS	2000		0		0	2,000		2,000.0
	EQUIPMENT MAINT (3.0 % OF CAPITAL)		20000 TON	3.5		0		0	70,000		70,000.0
	LEVEL C CONSUMABLES		2800 EA	38		0		0	106,400		106,400.0
	LEVEL C NON-CONSUMABLES		34 EA	131		0		0	4,454		4,454.0
	MISCELLANEOUS SUPPLIES		1 LS	20000		0		0	20,000		20,000.0
	WASTE DISPOSAL					0		0	0		0.0
	TAR GEN BY UV PROCESS		3500 GAL	10		0		0	35,000		35,000.0
	SPENT SCRUBBER SOLV AT COMPLETION		4000 GAL	10		0		0	40,000		40,000.0
	PROTECTIVE CLOTHING		300 PAC	100		0		0	30,000		30,000.0
	TOTAL					0			1831194		1,831,000.0

EG&G Idaho, Inc.

PROJECT _____ TYPE OF EST. _____ Date _____

LOCATION _____ SOURCE (E) Eng. Est. (V) Vendor (P) Pur. Order (H) Handbook Ref. Page 8 of 8

REQUESTER _____ Prep. By: _____

Appr'd By: _____

ACCT. NO.	DESCRIPTION	E,V, P,H	MAT'L UNIT	MAT'L WT. COST	UNIT LAB. HRS	TOTAL LAB. HR	LABOR RATE	LABOR COST	MAT'L COST	OTHER COST	TOTAL COST
	FILTER MEDIA		72 PAC	100		0		0	7,200		7,200.0
						0		0	0		0.0
						0		0	0		0.0
						0		0	0		0.0
	PERSONNEL					0		0	0		0.0
	PROCESS (30)		14 WK		1200	16800	30	504000	0		504,000.0
						0		0	0		0.0
	PER DIEM AND GENERAL EXPENSE		420 WK	300		0		0	126,000		126,000.0
						0		0	0		0.0
						0		0	0		0.0
	SUBTOTAL CAT 4 COSTS					0		0	0		2,468,000.0
	CONTINGENCY @ 20%					0		0	0		494,000.0
	GENERAL ADMINISTRATION @ 13%					0		0	0		385,000.0
	CONTRACTOR FEE @ 8%					0		0	0		268,000.0
	TOTAL CATEGORY 4					0		0	0		3,615,000.0
						0		0	0		
	CATEGORY 1 COSTS					0		0	0		2,497,000.0
	CATEGORY 2 COSTS					0		0	0		1,134,000.0
	CATEGORY 3 COSTS					0		0	0		785,000.0
	CATEGORY 4 COSTS					0		0	0		3,615,000.0
	TOTAL COSTS					0		0	0		8,031,000.0
	TOTAL					16800			133200		

EG&G Idaho, Inc.
40,000 TON CASE

PROJECT TD/UV DIOXIN CLEANUP---UPGRADE

LOCATION NCBC SITE AT GULFPORT, MISS.

REQUESTER R. W. THOMAS FILE NO. 8067-B

TYPE OF EST. CONCEPTUAL

SOURCE (E) Eng. Est.
(V) Vendor
(P) Pur. Order
(H) Handbook Ref.

Date JULY 2, 1987

Page 1 of 8

Prep. By: H. J. WELLAND

Appr'd By:

ACCT. NO.	DESCRIPTION	E,V, P,H	MAT'L UNIT	MAT'L UT. COST	UNIT LAB. HRS	TOTAL LAB. HR	LABOR RATE	LABOR COST	MAT'L COST	OTHER COST	TOTAL COST
	CATEGORY 1 COMMON REMEDIAL COSTS					0		0	0		0.0
	GEN MOB AND DEMOB		1 LS	82000		0		0	82,000		82,000.0
	ENGR (DEVELOP SITE & REPORTS)		1 LS	15000		0		0	15,000		15,000.0
	COMMUNITY RELATIONS SUPPORT		1 LS	40000		0		0	40,000		40,000.0
	CONSTRUCTION					0		0	0		0.0
	WATER TREATMENT FACILITY		1 LS	300000		0		0	300,000		300,000.0
	OFFICE TRAILER 10 X 50 FT		11 MO	380		0		0	4,180		4,180.0
	EMPLOYEE TRAILER (BREAKROOM)		11 MO	380		0		0	4,180		4,180.0
	FORKLIFT FOR MATL PREP		8 MO	1581		0		0	12,648		12,648.0
	UTILITY UPGRADE					0		0	0		0.0
	ELECTRICAL SERVICES CONSTRUCTION		1 LS	68000		0		0	68,000		68,000.0
	OUTDOOR LIGHTS		5 EA	1400		0		0	7,000		7,000.0
	WATER SUPPLY ALLOWANCE		1 LS	20000		0		0	20,000		20,000.0
	SEWER CONNECTION		1 LS	30000		0		0	30,000		30,000.0
	TELEPHONE SERVICE ALLOWANCE		1 LS	10000		0		0	10,000		10,000.0
	NATURAL GAS LINE		1 LS	30000		0		0	30,000		30,000.0
	VEHICLE DECON STATION		1 LS	30000		0		0	30,000		30,000.0
	DECON TRAILERS (2)		11 MO	2000		0		0	22,000		22,000.0
						0		0	0		0.0
	EXCAVATION - LOAD & HAUL					0		0	0		0.0
	10 CY DUMP TRUCK (2)		8 MO	10100		0		0	80,800		80,800.0
	TOTAL					0			755808		756,000.0

EG&G Idaho, Inc.

PROJECT _____ TYPE OF EST. _____ Date _____

LOCATION _____ SOURCE (E) Eng. Est. (V) Vendor (P) Pur. Order (H) Handbook Ref. Page 2 of 8

REQUESTER _____ Prep. By: _____

Appr'd By: _____

ACCT. NO.	DESCRIPTION	E,V, P,H	MAT'L UNIT	MAT'L UT. COST	UNIT LAB. HRS	TOTAL LAB. HRS	LABOR RATE	LABOR COST	MAT'L COST	OTHER COST	TOTAL COST
	4 CY FRONTEND LOADER		8 MO	12000		0		0	96,000		96,000.0
	2 CY FRONT ENDLOADER		8 MO	6000		0		0	48,000		48,000.0
	ROLLOFF BOX TRUCK		8 MO	1984		0		0	15,872		15,872.0
	SOIL STORAGE BIN MATERIAL (11)		1 LS	32000		0		0	32,000		32,000.0
	ROLLOFF BOXES FOR TREATED SOIL		5 EA	5000		0		0	25,000		25,000.0
	CRAWLER TRACTOR W/BLADE		8 MO	3200		0		0	25,600		25,600.0
	WATER TANKER FOR DUST CONTROL		8 MO	3000		0		0	24,000		24,000.0
	SITE RESTORATION					0		0	0		0.0
	10 CY DUMP TRUCK		8 MO	5050		0		0	40,400		40,400.0
	4 CY FRONTEND LOADER		8 MO	12000		0		0	96,000		96,000.0
	TOPSOIL PLACEMENT		3760 CY	13.5		0		0	50,760		50,760.0
	EROSION MATTING & RESEEDING		84700 SY	2.2		0		0	186,340		186,340.0
	PHYSICALS 2 PER WORKER		22 EA	600		0		0	13,200		13,200.0
	TRAINING		11 EA	1000		0		0	11,000		11,000.0
	LEVEL C PROTECTIVE EQUIPMENT (7/DY)		224 DY	443		0		0	99,232		99,232.0
	LEVEL D PROTECTIVE EQUIPMENT (7/DY)		224 DY	187		0		0	41,888		41,888.0
	PERSONNEL					0		0	0		0.0
	CONSTRUCTION PERSONNEL (18)		4.5 WK		720	3240	25	81000	0		81,000.0
	TRIAL BURN (OPER + BIN CONST-6)		4 WK		240	960	25	24000	0		24,000.0
	TREAT SOIL (11)		28 WK		440	12320	25	308000	0		308,000.0
	DECON/DISASSEMBLE (11)		3.5 WK		440	1540	25	38500	0		38,500.0
	TOTAL					18060			805292		1,257,000.0

EG&G Idaho, Inc.

PROJECT _____ TYPE OF EST. _____ Date _____

LOCATION _____ SOURCE (E) Eng. Est. (V) Vendor (P) Pur. Order (H) Handbook Ref. Page 3 of 8

REQUESTER _____ Prep. By: _____

Appr'd By: _____

ACCT. NO.	DESCRIPTION	E,V,P,H	MAT'L UNIT	MAT'L UT. COST	UNIT LAB. HRS	TOTAL LAB. HR	LABOR RATE	LABOR COST	MAT'L COST	OTHER COST	TOTAL COST
	HEALTH & SAFETY SU & TRL BN (1)		7.5 MK		40	300	25	7500	0		7,500.0
	HEALTH & SAFETY TRT SL (2)		28 MK		80	2240	25	56000	0		56,000.0
	HEALTH & SAFETY DECON/DISASSEMBL (1)		3.5 MK		40	140	25	3500	0		3,500.0
	PER DIEM (25 % LABOR)		39 MK	250		0		0	9,750		9,750.0
	SALVAGE ROLLOFF BOXES		5 EA	-2500		0		0	(12,500)		(12,500.0)
						0		0	0		0.0
						0		0	0		0.0
						0		0	0		0.0
						0		0	0		0.0
						0		0	0		0.0
	COMMON REMEDIAL COSTS SUBTOTAL					0		0	0		2,077,000.0
	CONTINGENCIES (25 %)					0		0	0		519,000.0
	GENERAL ADMINISTRATION (13 %)					0		0	0		337,000.0
	CONTRACTOR FEE (8 %)					0		0	0		235,000.0
	CATEGORY 1 TOTAL COMMON REMEDIAL COST					0		0	0		3,168,000.0
						0		0	0		0.0
						0		0	0		0.0
						0		0	0		0.0
						0		0	0		0.0
						0		0	0		0.0
						0		0	0		0.0
	TOTAL					2680			-2750		

EG&G Idaho, Inc.

PROJECT _____ TYPE OF EST. _____ Date _____

LOCATION _____ SOURCE (E) Eng. Est. Page 4 of 8

REQUESTER _____ (V) Vendor Prep. By: _____

(P) Pur. Order

(H) Handbook Ref. Appr'd By: _____

ACCT. NO.	DESCRIPTION	E,V, P,H	MAT'L UNIT	MAT'L UT. COST	UNIT LAB. HRS	TOTAL LAB. HR	LABOR RATE	LABOR COST	MAT'L COST	OTHER COST	TOTAL COST
	COMMON OPERATING & MONITORING COSTS					0		0	0		0.0
	MONITORING & ANALYSIS PROGRAM					0		0	0		0.0
	LAB FACILITY		11 MO	24000		0		0	264,000		264,000.0
	AREA AIR MONITORING STATIONS		4 EA	2500		0		0	10,000		10,000.0
	EXPENDABLES & MISC		32 WK	2500		0		0	80,000		80,000.0
	ANALYTICAL LAB OPERATION					0		0	0		0.0
	CHEMISTS (5)		31 WK		200	6200	35	217000	0		217,000.0
	TECHNICIANS (4)		28 WK		160	4480	23	103040	0		103,040.0
						0		0	0		0.0
						0		0	0		0.0
	FACILITY OPERATION					0		0	0		0.0
	GENERAL		32 WK	130		0		0	4,160		4,160.0
	CARBON REPLACEMENT		17000 LB	2		0		0	34,000		34,000.0
	MAINTENANCE		1 LS	30000		0		0	30,000		30,000.0
	DISCHARGE TO POTW		17000 KGAL	1.2		0		0	20,400		20,400.0
	FACILITY OPERATOR					0		0	0		0.0
	TRIAL BURN (2)		4 WK		80	320	26	8320	0		8,320.0
	PROCESS (2)		28 WK		80	2240	26	58240	0		58,240.0
						0		0	0		0.0
	PER DIEM FOR CHEM & TECH (25 %)		267 WK	300		0		0	80,100		80,100.0
						0		0	0		0.0
	TOTAL					13240			522660		909,260.0

E&G Idaho, Inc.

PROJECT _____ TYPE OF EST. _____ Date _____

LOCATION _____ SOURCE (E) Eng. Est. (V) Vendor (P) Pur. Order (H) Handbook Ref. Page 5 of 8

REQUESTER _____ Prep. By: _____

Appr'd By: _____

ACCT. NO.	DESCRIPTION	E,V,P,H	MAT'L UNIT	MAT'L UT. COST	UNIT LAB. HRS	TOTAL LAB. HR	LABOR RATE	LABOR COST	MAT'L COST	OTHER COST	TOTAL COST
	ON SCENE COORDINATOR (1)		41 WK		40	1640	25	41000	0		41,000.0
	PER DIEM (25 % LABOR)		41 WK	250		0		0	10,250		10,250.0
	STANDBY (2)		10 WK		80	800	25	20000	0		20,000.0
	WATER USER CHARGE		2400 KGAL	0.8		0		0	1,920		1,920.0
	ELECTRICITY ($.048 PER KWHR)		804 MWHR	48		0		0	38,592		38,592.0
						0		0	0		0.0
						0		0	0		0.0
	CHEMICAL ANALYSIS FOR TRIAL BURN					0		0	0		0.0
	PERSONNEL (5)		4 WK		200	800	55	44000	0		44,000.0
	SAMPLE ANALYSIS		1 LS	70000		0		0	70,000		70,000.0
	PER DIEM (25 % LABOR)		20 WK	550		0		0	11,000		11,000.0
						0		0	0		0.0
						0		0	0		0.0
						0		0	0		0.0
						0		0	0		0.0
	COMMON O & M COST SUBTOTAL					0		0	0		1,109,000.0
	CONTINGENCIES (20 %)					0		0	0		222,000.0
	GENERAL ADMINISTRATION (13 %)					0		0	0		173,000.0
	CONTRACTOR FEE (8 %)					0		0	0		120,000.0
	CATEGORY 2 COMMON O & M COSTS					0		0	0		1,624,000.0
						0		0	0		0.0
	TOTAL					3240			131762		

EG&G Idaho, Inc.

PROJECT _____ TYPE OF EST. _____ Date _____

LOCATION _____ SOURCE (E) Eng. Est. (V) Vendor (P) Pur. Order (H) Handbook Ref. Page 6 of 8

REQUESTER _____ Prep. By: _____

Appr'd By: _____

ACCT. NO.	DESCRIPTION	E,V, P,H	MAT'L UNIT	MAT'L UT. COST	UNIT LAB. HRS	TOTAL LAB. HR	LABOR RATE	LABOR COST	MAT'L COST	OTHER COST	TOTAL COST
	CATEGORY 3 TD/UV SETUP & REMOVAL					0		0	0		0.0
	PLNG & SITE PREPARATION		1 LS	54000		0		0	54,000		54,000.0
	LOAD & SHIP TO SITE & RETURN		1 LS	132000		0		0	132,000		132,000.0
						0		0	0		0.0
	OFF-LOAD & ASSEMBLE (11)		5.5 WK		440	2420	30	72600	0		72,600.0
	TRIAL BURN (10)		4 WK		400	1600	30	48000	0		48,000.0
	STANDBY (2)		10 WK		80	800	30	24000	0		24,000.0
	DECON AND DISASSEMBLE (11)		4.5 WK		440	1980	30	59400	0		59,400.0
	PER DIEM & GENERAL EXPENSE		164 WK	300		0		0	49,200		49,200.0
	MISCELLANEOUS SUPPLIES & EQUIP		1 LS	75000		0		0	75,000		75,000.0
	CATEGORY 3 SUBTOTAL					0		0	0		514,000.0
	CONTINGENCIES (25 %)					0		0	0		129,000.0
	GENERAL ADMINISTRATION (13 %)					0		0	0		84,000.0
	CONTRACTOR FEE (8 %)					0		0	0		58,000.0
	CATEGORY 3 TD/UV SETUP & TEARDOWN COSTS					0		0	0		785,000.0
						0		0	0		0.0
						0		0	0		0.0
						0		0	0		0.0
						0		0	0		0.0
						0		0	0		0.0
						0		0	0		0.0
	TOTAL					6800			310200		

EG&G Idaho, Inc.

PROJECT _____ TYPE OF EST. _____ Date _____

LOCATION _____ SOURCE (E) Eng. Est. (V) Vendor (P) Pur. Order (H) Handbook Ref. Page 7 of 8

REQUESTER _____ Prep. By: _____

Appr'd By: _____

ACCT. NO.	DESCRIPTION	E,V,P,H	MAT'L UNIT	MAT'L UT. COST	UNIT LAB. HRS	TOTAL LAB. HR	LABOR RATE	LABOR COST	MAT'L COST	OTHER COST	TOTAL COST
	CATEGORY 4 TD/UV O & M COSTS					0		0	0		0.0
	EQUIPMENT USE CHARGE		12 MO	102000		0		0	1,224,000		1,224,000.0
	UTILITIES					0		0	0		0.0
	ELECTRICITY		3500 MWHR	48		0		0	168,000		168,000.0
	NITROGEN		25200 KCF	4		0		0	100,800		100,800.0
	WATER USER CHARGE		10100 KGAL	0.8		0		0	8,080		8,080.0
	NATURAL GAS		101000 MBTU	5		0		0	505,000		505,000.0
	MAINTENANCE & MATERIALS					0		0	0		0.0
	SCRUBBER SOLVENT		11000 GAL	6		0		0	66,000		66,000.0
	ISOPROPYL ALCOHOL		2800 GAL	2		0		0	5,600		5,600.0
	ACTIVATED CARBON-EMMISSIONS CNTRL		140000 LB	1.85		0		0	259,000		259,000.0
	ACTIVATED CARBON-WASTE WATER TRTMT		28000 LB	1.4		0		0	39,200		39,200.0
	FILTER MEDIA REPLACEMENTS		1 LS	2000		0		0	2,000		2,000.0
	EQUIPMENT MAINT (3.0 % OF CAPITAL)		40000 TON	3.5		0		0	140,000		140,000.0
	LEVEL C CONSUMABLES		5600 EA	38		0		0	212,800		212,800.0
	LEVEL C NON-CONSUMABLES		34 EA	131		0		0	4,454		4,454.0
	MISCELLANEOUS SUPPLIES		1 LS	30000		0		0	30,000		30,000.0
	WASTE DISPOSAL					0		0	0		0.0
	TAR GEN BY UV PROCESS		7000 GAL	10		0		0	70,000		70,000.0
	SPENT SCRUBBER SOLV AT COMPLETION		4000 GAL	10		0		0	40,000		40,000.0
	PROTECTIVE CLOTHING		600 PAC	100		0		0	60,000		60,000.0
	TOTAL					0			2934934		2,935,000.0

EG&G Idaho, Inc.

PROJECT _____ TYPE OF EST. _____ Date _____

LOCATION _____ SOURCE (E) Eng. Est. (V) Vendor (P) Pur. Order (H) Handbook Ref. Page 0 of 0

REQUESTER _____ Prep. By: _____

Appr'd By: _____

ACCT. NO.	DESCRIPTION	E,V, P,H	MAT'L UNIT	MAT'L WT. COST	UNIT LAB. HRS	TOTAL LAB. HR	LABOR RATE	LABOR COST	MAT'L COST	OTHER COST	TOTAL COST
	FILTER MEDIA		144 PAC	100		0		0	14,400		14,400.0
						0		0	0		0.0
						0		0	0		0.0
						0		0	0		0.0
	PERSONNEL					0		0	0		0.0
	PROCESS (30)		28 MK		1200	33600	30	1008000	0		1,008,000.0
						0		0	0		0.0
	PER DIEM AND GENERAL EXPENSE		840 MK	300		0		0	252,000		252,000.0
						0		0	0		0.0
						0		0	0		0.0
	SUBTOTAL CAT 4 COSTS					0		0	0		4,209,000.0
	CONTINGENCY @ 20%					0		0	0		842,000.0
	GENERAL ADMINISTRATION @ 13%					0		0	0		637,000.0
	CONTRACTOR FEE @ 8%					0		0	0		457,000.0
	TOTAL CATEGORY 4					0		0	0		6,165,000.0
						0		0	0		
	CATEGORY 1 COSTS					0		0	0		3,168,000.0
	CATEGORY 2 COSTS					0		0	0		1,678,000.0
	CATEGORY 3 COSTS					0		0	0		785,000.0
	CATEGORY 4 COSTS					0		0	0		6,165,000.0
	TOTAL COSTS					0		0	0		11,796,000.0
	TOTAL					33600			266400		

EG&G Idaho, Inc.
10,000 TON CASE

PROJECT TD/UV DIOXIN CLEANUP---UPGRADE

LOCATION NCBC SITE AT GULFPORT, MISS.

REQUESTER R. W. THOMAS FILE NO. 8067-B

TYPE OF EST. CONCEPTUAL

SOURCE (E) Eng. Est.
(V) Vendor
(P) Pur. Order
(H) Handbook Ref.

Date JULY 2, 1987

Page 1 of 8

Prep. By: M. J. WELLAND

Appr'd By:

ACCT. NO.	DESCRIPTION	E,V, P,H	MAT'L UNIT	MAT'L UT. COST	UNIT LAB. HRS	TOTAL LAB. HR	LABOR RATE	LABOR COST	MAT'L COST	OTHER COST	TOTAL COST
	CATEGORY I COMMON REMEDIAL COSTS					0		0	0		0.0
	GEN MOB AND DEMOB		1 LS	82000		0		0	82,000		82,000.0
	ENGR (DEVELOP SITE & REPORTS)		1 LS	15000		0		0	15,000		15,000.0
	COMMUNITY RELATIONS SUPPORT		1 LS	40000		0		0	40,000		40,000.0
	CONSTRUCTION					0		0	0		0.0
	WATER TREATMENT FACILITY		1 LS	300000		0		0	300,000		300,000.0
	OFFICE TRAILER 10 X 50 FT		6 MO	380		0		0	2,280		2,280.0
	EMPLOYEE TRAILER (BREAKROOM)		6 MO	380		0		0	2,280		2,280.0
	FORKLIFT FOR MATL PREP		3 MO	1581		0		0	4,743		4,743.0
	UTILITY UPGRADE					0		0	0		0.0
	ELECTRICAL SERVICES CONSTRUCTION		1 LS	68000		0		0	68,000		68,000.0
	OUTDOOR LIGHTS		5 EA	1400		0		0	7,000		7,000.0
	WATER SUPPLY ALLOWANCE		1 LS	20000		0		0	20,000		20,000.0
	SEWER CONNECTION		1 LS	30000		0		0	30,000		30,000.0
	TELEPHONE SERVICE ALLOWANCE		1 LS	10000		0		0	10,000		10,000.0
	NATURAL GAS LINE		1 LS	30000		0		0	30,000		30,000.0
	VEHICLE DECON STATION		1 LS	30000		0		0	30,000		30,000.0
	DECON TRAILERS (2)		6 MO	2000		0		0	12,000		12,000.0
						0		0	0		0.0
	EXCAVATION - LOAD & HAUL					0		0	0		0.0
	10 CY DUMP TRUCK (2)		3 MO	10100		0		0	30,300		30,300.0
	TOTAL					0			683603		684,000.0

E&E Idaho, Inc.

PROJECT _____ TYPE OF EST. _____ Date _____

LOCATION _____ SOURCE (E) Eng. Est. (V) Vendor (P) Pur. Order (H) Handbook Ref. Page 2 of 8

REQUESTER _____ Prep. By: _____

Appr'd By: _____

ACCT. NO.	DESCRIPTION	E,V, P,H	MAT'L UNIT	MAT'L UT. COST	UNIT LAB. HRS	TOTAL LAB. HR	LABOR RATE	LABOR COST	MAT'L COST	OTHER COST	TOTAL COST
	4 CY FRONTEND LOADER		3 MO	12000		0		0	36,000		36,000.0
	2 CY FRONTEND LOADER		3 MO	6000		0		0	18,000		18,000.0
	ROLLOFF TRUCK		3 MO	1984		0		0	5,952		5,952.0
	SOIL STORAGE BIN MATERIAL (11)		1 LS	32000		0		0	32,000		32,000.0
	ROLLOFF BOXES FOR TREATED SOIL		5 EA	5000		0		0	25,000		25,000.0
	CRAWLER TRACTOR W/BLADE		3 MO	3200		0		0	9,600		9,600.0
	WATER TANKER FOR DUST CONTROL		3 MO	3000		0		0	9,000		9,000.0
	SITE RESTORATION					0		0	0		0.0
	10 CY DUMP TRUCK		3 MO	5050		0		0	15,150		15,150.0
	4 CY FRONTEND LOADER		3 MO	12000		0		0	36,000		36,000.0
	TOPSOIL PLACEMENT		940 CY	13.5		0		0	12,690		12,690.0
	EROSION MATTING & RESEEDING		84700 SY	2.2		0		0	186,340		186,340.0
	PHYSICALS 2 PER WORKER		22 EA	600		0		0	13,200		13,200.0
	TRAINING		11 EA	1000		0		0	11,000		11,000.0
	LEVEL C PROTECTIVE EQUIPMENT (7/DY)		73 DY	443		0		0	32,339		32,339.0
	LEVEL D PROTECTIVE EQUIPMENT (7/DY)		73 DY	187		0		0	13,651		13,651.0
	PERSONNEL					0		0	0		0.0
	CONSTRUCTION PERSONNEL (18)		4.5 WK		720	3240	25	81000	0		81,000.0
	TRIAL BURN (OPER + BIN CONST-6)		4 WK		240	960	25	24000	0		24,000.0
	TREAT SOIL (11)		7 WK		440	3080	25	77000	0		77,000.0
	DECON/DISASSEMBLE (11)		3.5 WK		440	1540	25	38500	0		38,500.0
	TOTAL					8820			455922		676,000.0

EG&G Idaho, Inc.

PROJECT _____ TYPE OF EST. _____ Date _____

LOCATION _____ SOURCE (E) Eng. Est. (V) Vendor (P) Pur. Order (N) Handbook Ref. Page 3 of 8

REQUESTER _____ Prep. By: _____

Appr'd By: _____

ACCT. NO.	DESCRIPTION	E,V, P,H	MAT'L UNIT	MAT'L UT. COST	UNIT LAB. HRS	TOTAL LAB. HR	LABOR RATE	LABOR COST	MAT'L COST	OTHER COST	TOTAL COST
	HEALTH & SAFETY SU & TRL BN (1)		7.5 WK		40	300	25	7500	0		7,500.0
	HEALTH & SAFETY TRT SL (2)		7 WK		80	560	25	14000	0		14,000.0
	HEALTH & SAFETY DECON/DISASSEMBLY (1)		3.5 WK		40	140	25	3500	0		3,500.0
	PER DIEM (25 % LABOR)		25 WK	250		0		0	6,250		6,250.0
	SALVAGE ROLLOFF BOXES		5 EA	-2500		0		0	(12,500)		(12,500.0)
						0		0	0		0.0
						0		0	0		0.0
						0		0	0		0.0
						0		0	0		0.0
						0		0	0		0.0
	COMMON REMEDIAL COSTS SUBTOTAL					0		0	0		1,379,000.0
	CONTINGENCIES (25 %)					0		0	0		345,000.0
	GENERAL ADMINISTRATION (13 %)					0		0	0		224,000.0
	CONTRACTOR FEE (8 %)					0		0	0		156,000.0
	CATEGORY 1 TOTAL COMMON REMEDIAL COST					0		0	0		2,104,000.0
						0		0	0		0.0
						0		0	0		0.0
						0		0	0		0.0
						0		0	0		0.0
						0		0	0		0.0
						0		0	0		0.0
	TOTAL					1000			-6250		

EG&G Idaho, Inc.

PROJECT _____ TYPE OF EST. _____ Date _____

LOCATION _____ SOURCE (E) Eng. Est. Page 4 of 8

REQUESTER _____ (V) Vendor (P) Pur. Order (H) Handbook Ref. Prep. By: _____

Appr'd By: _____

ACCT. NO.	DESCRIPTION	E,V, P,H	MAT'L UNIT	MAT'L UT. COST	UNIT LAB. HRS	TOTAL LAB. HR	LABOR RATE	LABOR COST	MAT'L COST	OTHER COST	TOTAL COST
	COMMON OPERATING & MONITORING COSTS					0		0	0		0.0
	MONITORING & ANALYSIS PROGRAM					0		0	0		0.0
	LAB FACILITY		6 MO	24000		0		0	144,000		144,000.0
	AREA AIR MONITORING STATIONS		4 EA	2500		0		0	10,000		10,000.0
	EXPENDABLES & MISC		11 MK	2500		0		0	27,500		27,500.0
	ANALYTICAL LAB OPERATION					0		0	0		0.0
	CHEMISTS (5)		10 MK		200	2000	35	70000	0		70,000.0
	TECHNICIANS (4)		7 MK		160	1120	23	25760	0		25,760.0
						0		0	0		0.0
						0		0	0		0.0
	FACILITY OPERATION					0		0	0		0.0
	GENERAL		11 MK	130		0		0	1,430		1,430.0
	CARBON REPLACEMENT		17000 LB	2		0		0	34,000		34,000.0
	MAINTENANCE		1 LS	15000		0		0	15,000		15,000.0
	DISCHARGE TO POTW		17000 KGAL	1.2		0		0	20,400		20,400.0
	FACILITY OPERATOR					0		0	0		0.0
	TRIAL BURN (2)		4 MK		80	320	26	8320	0		8,320.0
	PROCESS (2)		7 MK		80	560	26	14560	0		14,560.0
						0		0	0		0.0
	PER DIEM FOR CHEM & TECH (25%)		70 MK	303		0		0	23,634		23,634.0
						0		0	0		0.0
	TOTAL					4000			279964		394,604.0

EG&G Idaho, Inc.

PROJECT ---------- TYPE OF EST. ---------- Date ---------

LOCATION ---------- SOURCE (E) Eng. Est. (V) Vendor (P) Pur. Order (H) Handbook Ref. Page 5 of 8

REQUESTER ---------- Prep. By: ---------

Appr'd By: ---------

ACCT. NO.	DESCRIPTION	E,V,P,H	MAT'L UNIT	MAT'L UT. COST	UNIT LAB. HRS	TOTAL LAB. HR	LABOR RATE	LABOR COST	MAT'L COST	OTHER COST	TOTAL COST
	ON SCENE COORDINATOR (1)		19 WK		40	760	25	19000	0		19,000.0
	PER DIEM (25 % LABOR)		19 WK	250		0		0	4,750		4,750.0
	STANDBY (2)		10 WK		80	800	25	20000	0		20,000.0
	WATER USER CHARGE		2400 KGAL	0.8		0		0	1,920		1,920.0
	ELECTRICITY ($.048 PER KWHR)		230 MWHR	48		0		0	11,040		11,040.0
						0		0	0		0.0
						0		0	0		0.0
	CHEMICAL ANALYSIS FOR TRIAL BURN					0		0	0		0.0
	PERSONNEL (5)		4 WK		200	800	55	44000	0		44,000.0
	SAMPLE ANALYSIS		1 LS	70000		0		0	70,000		70,000.0
	PER DIEM (25 % LABOR)		20 WK	550		0		0	11,000		11,000.0
						0		0	0		0.0
						0		0	0		0.0
						0		0	0		0.0
						0		0	0		0.0
	COMMON O & M COST SUBTOTAL					0		0	0		576,000.0
	CONTINGENCIES (20 %)					0		0	0		115,000.0
	GENERAL ADMINISTRATION (13 %)					0		0	0		90,000.0
	CONTRACTOR FEE (8 %)					0		0	0		62,000.0
	CATEGORY 2 COMMON O & M COSTS					0		0	0		843,000.0
						0		0	0		0.0
	TOTAL					2360			98710		

EG&G Idaho, Inc.

PROJECT _____ TYPE OF EST. _____ Date _____

LOCATION _____ SOURCE (E) Eng. Est. (V) Vendor (P) Pur. Order (H) Handbook Ref. Page 6 of 8

REQUESTER _____ Prep. By: _____

Appr'd By: _____

ACCT. NO.	DESCRIPTION	E,V,P,H	MAT'L UNIT	MAT'L UT. COST	UNIT LAB. HRS	TOTAL LAB. HR	LABOR RATE	LABOR COST	MAT'L COST	OTHER COST	TOTAL COST
	CATEGORY 3 TD/UV SETUP & REMOVAL					0		0	0		0.0
	PLNG & SITE PREPARATION		1 LS	54000		0		0	54,000		54,000.0
	LOAD & SHIP TO SITE & RETURN		1 LS	132000		0		0	132,000		132,000.0
						0		0	0		0.0
	OFF-LOAD & ASSEMBLE (11)		5.5 WK		440	2420	30	72600	0		72,600.0
	TRIAL BURN (10)		4 WK		400	1600	30	48000	0		48,000.0
	STANDBY (2)		10 WK		80	800	30	24000	0		24,000.0
	DECON AND DISASSEMBLE (11)		4.5 WK		440	1980	30	59400	0		59,400.0
	PER DIEM & GENERAL EXPENSE		164 WK	300		0		0	49,200		49,200.0
	MISCELLANEOUS SUPPLIES & EQUIP		1 LS	75000		0		0	75,000		75,000.0
	CATEGORY 3 SUBTOTAL					0		0	0		514,000.0
	CONTINGENCIES (25 %)					0		0	0		129,000.0
	GENERAL ADMINISTRATION (13 %)					0		0	0		84,000.0
	CONTRACTOR FEE (8 %)					0		0	0		58,000.0
	CATEGORY 3 TD/UV SETUP & TEARDOWN COSTS					0		0	0		785,000.0
						0		0	0		0.0
						0		0	0		0.0
						0		0	0		0.0
						0		0	0		0.0
						0		0	0		0.0
						0		0	0		0.0
	TOTAL					6800			310200		

EG&G Idaho, Inc.

PROJECT _____ TYPE OF EST. _____ Date _____

LOCATION _____ SOURCE (E) Eng. Est. (V) Vendor (P) Pur. Order (H) Handbook Ref. Page 7 of 8

REQUESTER _____ Prep. By: _____

Appr'd By: _____

ACCT. NO.	DESCRIPTION	E,V,P,H	MAT'L UNIT	MAT'L UT. COST	UNIT LAB. HRS	TOTAL LAB. HR	LABOR RATE	LABOR COST	MAT'L COST	OTHER COST	TOTAL COST
	CATEGORY 4 TB/UV O & M COSTS					0		0	0		0.0
	EQUIPMENT USE CHARGE		7 MO	102000		0		0	714,000		714,000.0
	UTILITIES					0		0	0		0.0
	ELECTRICITY		982 MWHR	48		0		0	47,136		47,136.0
	NITROGEN		7200 KCF	4		0		0	28,800		28,800.0
	WATER USER CHARGE		2900 KGAL	0.8		0		0	2,320		2,320.0
	NATURAL GAS		29000 MBTU	5		0		0	145,000		145,000.0
	MAINTENANCE & MATERIALS					0		0	0		0.0
	SCRUBBER SOLVENT		5800 GAL	6		0		0	34,800		34,800.0
	ISOPROPYL ALCOHOL		700 GAL	2		0		0	1,400		1,400.0
	ACTIVATED CARBON-EMMISSIONS CNTRL		35000 LB	1.85		0		0	64,750		64,750.0
	ACTIVATED CARBON-WASTE WATER TRTMT		7000 LB	1.4		0		0	9,800		9,800.0
	FILTER MEDIA REPLACEMENTS		1 LS	2000		0		0	2,000		2,000.0
	EQUIPMENT MAINT (3.0 % OF CAPITAL)		10000 TON	3.5		0		0	35,000		35,000.0
	LEVEL C CONSUMABLES		1400 EA	38		0		0	53,200		53,200.0
	LEVEL C NON-CONSUMABLES		34 EA	131		0		0	4,454		4,454.0
	MISCELLANEOUS SUPPLIES		1 LS	15000		0		0	15,000		15,000.0
	WASTE DISPOSAL					0		0	0		0.0
	TAR GEN BY UV PROCESS		1800 GAL	10		0		0	18,000		18,000.0
	SPENT SCRUBBER SOLV AT COMPLETION		4000 GAL	10		0		0	40,000		40,000.0
	PROTECTIVE CLOTHING		150 PAC	100		0		0	15,000		15,000.0
	TOTAL					0			1230660		1,231,000.0

E&G Idaho, Inc.

PROJECT _____ TYPE OF EST. _____ Date _____

LOCATION _____ SOURCE (E) Eng. Est. (V) Vendor (P) Pur. Order (H) Handbook Ref. Page 8 of 8

REQUESTER _____ Prep. By: _____

Appr'd By: _____

ACCT. NO.	DESCRIPTION	E,V, P,H	MAT'L UNIT	MAT'L UT. COST	UNIT LAB. HRS	TOTAL LAB. HR	LABOR RATE	LABOR COST	MAT'L COST	OTHER COST	TOTAL COST
	FILTER MEDIA		36 PAC	100		0		0	3,600		3,600.0
						0		0	0		0.0
						0		0	0		0.0
						0		0	0		0.0
	PERSONNEL					0		0	0		0.0
	PROCESS (30)		7 WK		1200	8400	30	252000	0		252,000.0
						0		0	0		0.0
	PER DIEM AND GENERAL EXPENSE		210 WK	300		0		0	63,000		63,000.0
						0		0	0		0.0
						0		0	0		0.0
	SUBTOTAL CAT 4 COSTS					0		0	0		1,550,000.0
	CONTINGENCY @ 20%					0		0	0		310,000.0
	GENERAL ADMINISTRATION @ 13%					0		0	0		242,000.0
	CONTRACTOR FEE @ 8%					0		0	0		168,000.0
	TOTAL CATEGORY 4					0		0	0		2,270,000.0
						0		0	0		
	CATEGORY 1 COSTS					0		0	0		2,104,000.0
	CATEGORY 2 COSTS					0		0	0		843,000.0
	CATEGORY 3 COSTS					0		0	0		785,000.0
	CATEGORY 4 COSTS					0		0	0		2,270,000.0
	TOTAL COSTS					0		0	0		6,002,000.0
	TOTAL					8400			66600		

NCBC TD/UV PROCESS

PAGE 1

SENSITIVITY STUDY

TRANSPORTATION COSTS

	DESCRIPTION	BASELINE COST	100% COST		-50% COST						
CAT 1	NO SHIPPING	$0	$0		$0						
CAT 2	NO SHIPPING	$0	$0		$0						
CAT 3	EQUIPMENT	$94,860	$189,720		$47,430						
CAT 4	NO SHIPPING	$0	$0		$0						
TOTAL TRANSPORTATION		$94,860	$189,720		$47,430						
							COST PER TON				
TOTAL COSTS				DELTA COST		DELTA COST	BASELINE	100 %	DELTA	-50 %	DELTA
CAT 1		$2,497,000	$2,497,000	$0	$2,497,000	$0	$124.85	$124.85	$0.00	$124.85	$0.00
CAT 2		$1,134,000	$1,134,000	$0	$1,134,000	$0	$56.70	$56.70	$0.00	$56.70	$0.00
CAT 3		$785,000	$880,000	$95,000	$738,000	($47,000)	$39.25	$44.00	$4.75	$36.90	($2.35)
CAT 4		$3,615,000	$3,615,000	$0	$3,615,000	$0	$180.75	$180.75	$0.00	$180.75	$0.00
TOTAL COSTS		$8,031,000	$8,126,000	$95,000	$7,984,000	($47,000)	$401.55	$406.30	$4.75	$399.20	($2.35)

SENSITIVITY STUDY

UTILITY COSTS

	DESCRIPTION	BASELINE COST	100% COST		-50% COST						
CAT 1	NO UTILITY COSTS	$0	$0		$0						
CAT 2	FACILITY OPERATION										
	ELECTRICITY	$29,504	$59,007		$14,752						
	WATER	$2,803	$5,606		$1,402						
CAT 3	NO UTILITY COSTS	$0	$0		$0						
CAT 4	PROCESS EQUIP OPER										
	ELECTRICITY	$126,144	$252,288		$63,072						
	WATER	$6,190	$12,381		$3,095						
	NAT GAS	$386,900	$773,800		$193,450						
TOTAL UTILITY COSTS		$551,541	$1,103,083		$275,771						
								COST PER TON			
TOTAL COSTS				DELTA COST		DELTA COST	BASELINE	100 %	DELTA	-50 %	DELTA
CAT 1		$2,497,000	$2,497,000	$0	$2,497,000	$0	$124.85	$124.85	$0.00	$124.85	$0.00
CAT 2		$1,134,000	$1,166,000	$32,000	$1,118,000	($16,000)	$56.70	$58.30	$1.60	$55.90	($0.80)
CAT 3		$785,000	$785,000	$0	$785,000	$0	$39.25	$39.25	$0.00	$39.25	$0.00
CAT 4		$3,615,000	$4,134,000	$519,000	$3,355,000	($260,000)	$180.75	$206.70	$25.95	$167.75	($13.00)
TOTAL COSTS		$8,031,000	$8,582,000	$551,000	$7,755,000	($276,000)	$401.55	$429.10	$27.55	$387.75	($13.80)

SENSITIVITY STUDY

LABOR COSTS

	DESCRIPTION	BASELINE COST	+100% COST	-50% COST
CAT 1	CONST PERSONNEL	$123,930	$247,860	$61,965
	TRIAL BURN	$36,720	$73,440	$18,360
	TREAT SOIL	$235,620	$471,240	$117,810
	DECON/DISASSEMBLE	$58,905	$117,810	$29,453
	H & S SU & TRL BN	$13,005	$26,010	$6,503
	H & S TRT SL	$42,840	$85,680	$21,420
	H & S DECON/DIS	$6,885	$13,770	$3,443
CAT 2	CHEMISTS	$173,740	$347,480	$86,870
	TECHNICIANS	$75,219	$150,438	$37,610
	FAC OP TRL BN	$12,147	$24,294	$6,074
	FAC OP TRT SL	$42,515	$85,030	$21,258
	STANDBY	$29,200	$58,400	$14,600
	ON SCENE COORD	$37,960	$75,920	$18,980
	TRL BN CHEM	$64,240	$128,480	$32,120
CAT 3	OFF LD & ASSEMBLE	$111,078	$222,156	$55,539
	TRL BN	$73,440	$146,880	$36,720
	STANDBY	$36,720	$73,440	$18,360
	DECON & DISASSEMBLE	$90,882	$181,764	$45,441
CAT 4	SOIL TRTMT	$735,840	$1,471,680	$367,920
TOTAL LABOR COSTS		$2,000,887	$4,001,773	$1,000,443

TOTAL COSTS			DELTA COST		DELTA COST	COST PER TON BASELINE	100 %	DELTA	-50 %	DELTA
CAT 1	$2,497,000	$3,015,000	$518,000	$2,262,910	($234,090)	$124.85	$150.75	$25.90	$113.15	($11.70)
CAT 2	$1,134,000	$1,569,000	$435,000	$913,047	($220,953)	$56.70	$78.45	$21.75	$45.65	($11.05)
CAT 3	$785,000	$1,097,000	$312,000	$628,940	($156,060)	$39.25	$54.85	$15.60	$31.45	($7.80)
CAT 4	$3,615,000	$4,351,000	$736,000	$3,247,080	($367,920)	$180.75	$217.55	$36.80	$162.35	($18.40)
TOTAL COSTS	$8,031,000	$10,032,000	$2,001,000	$7,051,977	($979,023)	$401.55	$501.60	$100.05	$352.60	($48.95)

SENSITIVITY STUDY
EQUIPMENT USE CHARGES
PROCESS EQUIPMENT ONLY

DESCRIPTION	BASELINE COST	+100% COST		-50% COST						
CAT 4 EQUIP USE	$1,340,000	$2,680,000		$670,000						
							COST PER TON			
TOTAL COSTS			DELTA COST		DELTA COST	BASELINE	100 %	DELTA	-50 %	DELTA
CAT 4	$3,615,000	$4,955,000	$1,340,000	$2,945,000	($670,000)	$180.75	$247.75	$67.00	$147.25	($33.50)
TOTAL COSTS	$8,031,000	$9,371,000	$1,340,000	$7,361,000	($670,000)	$401.55	$468.55	$67.00	$368.05	($33.50)

SENSITIVITY STUDY

REDUCED QUANTITY

10,000 TONS OF CONTAMINATED SOIL

		BASELINE COST	REDUCED QUANTITY COST	DELTA COST	COST PER TON BASELINE	COST PER TON REDUCED	COST PER TON DELTA
CAT 1	COMMON REMEDIAL	$2,497,000	$2,104,000	($393,000)	$124.85	$210.40	$85.55
CAT 2	COMMON O & M	$1,134,000	$843,000	($291,000)	$56.70	$84.30	$27.60
CAT 3	TD/UV SITE SETUP	$785,000	$785,000	$0	$39.25	$78.50	$39.25
CAT 4	TD/UV FACILITY O & M	$3,615,000	$2,270,000	($1,345,000)	$180.75	$227.00	$46.25
TOTAL COSTS		$8,031,000	$6,002,000	($2,029,000)	$401.55	$600.20	$198.65

INCREASED QUANTITY

40,000 TONS OF CONTAMINATED SOIL

		BASELINE COST	INCREASED QUANTITY COST	DELTA COST	COST PER TON BASELINE	COST PER TON REDUCED	COST PER TON DELTA
CAT 1	COMMON REMEDIAL	$2,497,000	$3,168,000	$671,000	$124.85	$79.20	($45.65)
CAT 2	COMMON O & M	$1,134,000	$1,678,000	$544,000	$56.70	$41.95	($14.75)
CAT 3	TD/UV SITE SETUP	$785,000	$785,000	$0	$39.25	$19.63	($19.63)
CAT 4	TD/UV FACILITY O & M	$3,615,000	$6,165,000	$2,550,000	$180.75	$154.13	($26.63)
TOTAL COSTS		$8,031,000	$11,796,000	$3,765,000	$401.55	$294.90	($106.65)

SENSITIVITY STUDY

SYSTEM FEED RATE

	DESCRIPTION	BASELINE COST	13 TON PER HOUR COST	13 TON PER HOUR DELTA COST	7 TON PER HOUR COST	7 TON PER HOUR DELTA COST	COST PER TON BASELINE	COST PER TON 13 TON/HR	COST PER TON DELTA	COST PER TON 7 TON/HR	COST PER TON DELTA
CAT 1	COMMON REMEDIAL COST	$2,497,000	$2,300,000	($197,000)	$2,722,000	$225,000	$124.85	$115.00	($9.85)	$136.10	$11.25
CAT 2	COMMON O & M COSTS	$1,134,000	$983,000	($151,000)	$1,337,000	$203,000	$56.70	$49.15	($7.55)	$66.85	$10.15
CAT 3	TD/UV SITE SETUP	$785,000	$785,000	$0	$785,000	$0	$39.25	$39.25	$0.00	$39.25	$0.00
CAT 4	TD/UV FACILITY O & M	$3,615,000	$3,080,000	($535,000)	$4,344,000	$729,000	$180.75	$154.00	($26.75)	$217.20	$36.45
TOTAL COSTS		$8,031,000	$7,148,000	($883,000)	$9,188,000	$1,157,000	$401.55	$357.40	($44.15)	$459.40	$57.85